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TO WHOM THIS VOLUME IS DEDICATED  
IN HONOUR OF HER 90TH BIRTHDAY IN 1967



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THE GENUS *DIOSCOREA* IN THE  
CAPE PROVINCE WEST  
OF EAST LONDON

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ABSTRACT.

In this paper the distribution of the eight species of *Dioscorea* occurring in the most southerly part of South Africa is given. The persistence of the aerial shoot under natural conditions for more than one season is reported for the first time in the genus. Tubers are described and compared; particular reference is made to an interesting form of perennial tuber; a fundamental difference in the development of two forms of tubers as seen in the seedling stage is noted. The phylogeny of the species is discussed and a new section to include three species endemic to the area is suggested. A complete description accompanied by line drawings is given for each species. The species under consideration are *Dioscorea burchellii*, *D. cotinifolia*, *D. elephantipes*, *D. hemicrypta*, *D. mundtii*, *D. rupicola*, *D. stipulosa* and *D. sylvatica*.

DISTRIBUTION.

The Cape Province west of East London and Queenstown has a temperate climate with rainfall varying from a summer maximum in the east to a winter maximum in the west as shown diagrammatically in Fig. 1. In the part of the Cape Province which lies to the east of East London both the climate and the flora are predominantly sub-tropical and hence this division is taken as a convenient geographical limit for dealing with the species of *Dioscorea*. By contrast the flora of the Western Cape is a well defined  *fynbos*  (*macchia*), while inland behind the coastal mountain ranges in the more arid regions, the Karoo Flora is dominant, giving place to the Grassland Flora on the inland plateaux

where the rainfall is higher. Therefore in the area under consideration, that is west of a line drawn between East London and Queenstown, all four floral types are represented. In the transitional climatic region where they converge (the Eastern Cape Province), each contributes a rich quota of species and here aspect may be the leading factor in determining which predominates.

Of the eight species of *Dioscorea* known to occur west of East London four, *D. cotinifolia*, *D. mundtii*, *D. rupicola* and *D. sylvatica*, occur in communities of sub-tropical affinity, two, *D. burchellii* and *D. stipulosa* occur in fynbos and two, *D. elephantipes* and *D. hemicrypta* occur in Karroid communities. Their geographical distribution is shown in Fig. 1 and detailed ecological data and records are given subsequently under the relevant description for each species.

Observations which suggest that temperature and rainfall are important factors in controlling distribution were made in the case of *D. cotinifolia*. This species flourishes in the Transvaal and Natal but is at the southernmost end of its range in the area under consideration. It was collected in the Port Elizabeth Division in 1930 (Long 139, van Stadens), but this has not been confirmed in recent years, and the observations referred to were made at Port Alfred in the Bathurst Division, the next most southerly place where it has been recorded. During the period June, 1961 to February, 1965 when field observations were made, male inflorescences were regularly formed every season but they were never as abundant as in specimens from Komga in the subtropical region just east of East London, and female flowers were generally scarce at Port Alfred. After excessive rains in March 1963 male flowers were present in November-December, but the buds failed to open. They were well developed but withered away after about four weeks. Mean rainfall and temperature readings over the months October, November, December are given for four stations along the coast in Table 1.

TABLE 1.  
October to December: Rainfall and Temperature

					Temperature °F		
					Difference		
					Mean Max.		
					Mean Min.	Abs. Max.	Abs. Min.
Port Elizabeth	..	..	..	6.00	12.6	107.0	43.0
Port Alfred	..	..	..	7.05	18.0	107.0	42.0
East London	..	..	..	9.82	13.6	104.0	42.0
Durban	..	..	..	14.98	11.2	99.6	75.2

It is suggested that the drop in temperature at night during early summer combined with lower rainfall is sufficient to inhibit proper opening of flowers.

In a sheltered inland valley about 15 miles distant from the Port Alfred coast, flowers were not abundant either but in the winter of 1961 a number of very young seedlings were found as well as juvenile plants with well developed tubers suggesting that this area was more favourable for the opening of flowers and the formation of seed.

### *The Aerial Shoot*

Burkill states (1960) that it is a family characteristic of the Dioscoreaceae that the aerial stem is annually formed and replaced. He cites only two reported cases of persistent aerial stems, one is that of a new genus from Madagascar published in 1925 (Perrier de la Bâthie) and typified by the species *Avetra sempervirens*. It is described by Perrier de la Bâthie as having a persistent stem. The other record is by Human (1916) who gave an account of *Dioscorea multiflora* belonging to the section *Sphaerantha*, growing in cultivation in Buenos Aires, which he said had an evergreen stem. Burkill states, without evidence, that "there are strong reasons for holding that in these plants the stem does not continue active through a second year". In fact, of the eight species dealt with in this paper, three species, and possibly also two others, are known to have aerial stems which persist for at least two years. This can be made clear by following the development of the aerial shoot during the seasonal changes in a typical 'annual' species and comparing it with what happens in the 'perennial' species.

In *D. rupicola* a new shoot is formed from the tuber crown in October. Its growth is rapid and vigorous, flowers are present in November-December and capsules open to shed seeds in May. By this time leaf-fall has already started and by mid-winter (July) the vine is bare and lifeless, dying back completely before the annual renewal of the shoot *ab initio* from the tuber crown towards the end of spring.

In species with a 'persistent' aerial stem only the uppermost aerial parts are deciduous, the lower laterals and main stem remain dormant during the winter and some of the lower leaves also remain green during this period. When the growing season starts new shoots are produced from axillary buds either on the main stem or lower laterals. Aerial stems persisting for more than one season and giving rise to the new season's growth in this way have been observed in *D. cotinifolia* and *D. sylvatica*, where the growing season starts in August-September; and in *D. mundtii*, an autumn flowering species in which the growing season starts in January and which is confined to the George and Knysna Divisions. Stems showing this form of regeneration are shown in Figs. 2, 7 and 10 and specimens have been distributed to certain herbaria. In *D. cotinifolia*, *D. sylvatica* and *D. mundtii* even young plants which are not sufficiently mature



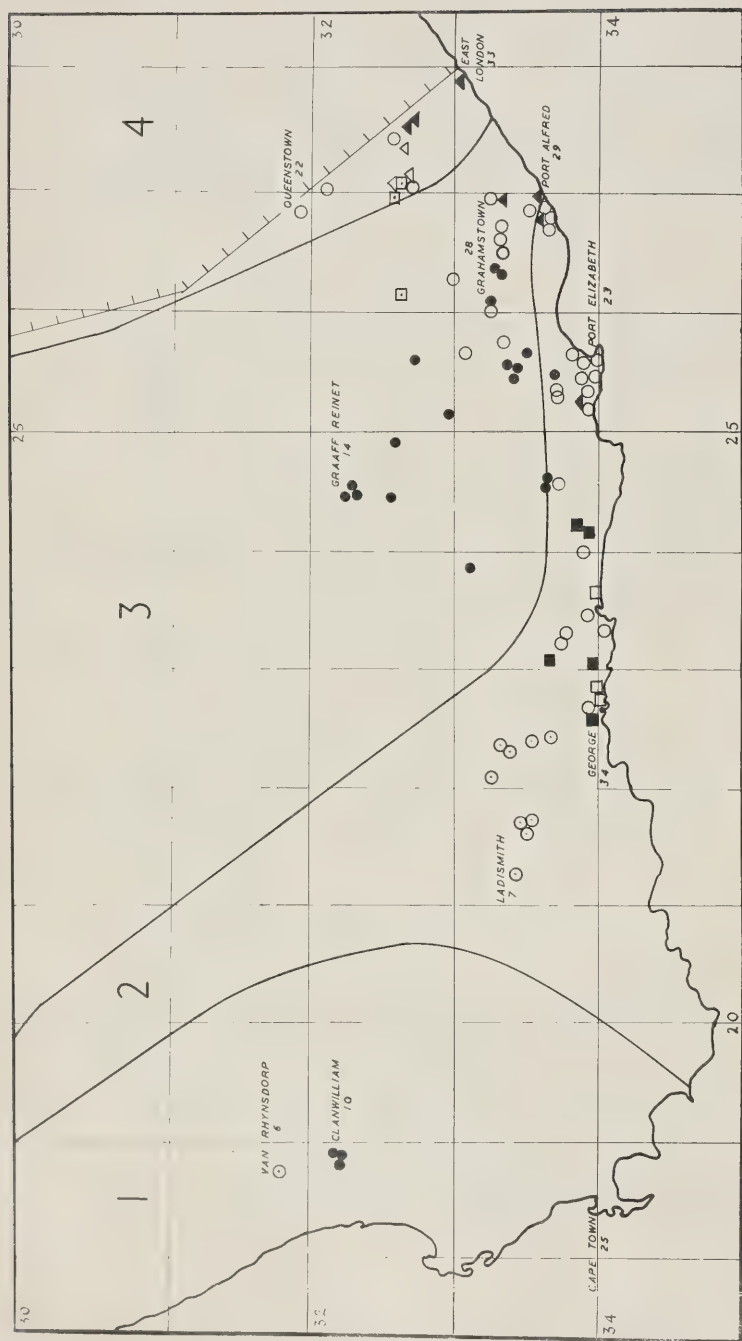


FIG. 1.

Map of Cape Province west of East London and Queenstown showing seasonal rainfall zones (after T. E. W. Schumann) and distribution of eight species of *Dioscorea*. Rainfall areas: 1. Winter; 2. All-season; 3. Summer (max. in March); 4. Summer (max. in January to March). Average annual rainfall in inches is given next to the places named.

- |   |                        |   |                      |
|---|------------------------|---|----------------------|
| ▲ | <i>D. cotinifolia</i>  | △ | <i>D. rupicola</i>   |
| ○ | <i>D. sylvatica</i>    | □ | <i>D. mundtii</i>    |
| ● | <i>D. elephantipes</i> | ■ | <i>D. burchellii</i> |
| ○ | <i>D. hemitrypta</i>   | □ | <i>D. stipulosa</i>  |

to flower show this persistence of the aerial stem and regeneration from primary or secondary axillary buds.

It is not known how long the main stem persists. In *D. cotinifolia* specimens under observation which produced a new main shoot from the tuber in 1963, produced laterals from aerial buds in 1964 and again in 1965. In *D. sylvatica* aerial shoots collected in the fields show on the main stem the stumpy remains of previous aerial branches for at least two and possibly for five previous periods of growth. In the case of *D. burchellii*, a rare autumn flowering species occurring in the tall fynbos of the George Division, plants could not be kept under regular observation. However vines marked in May 1963 were still in leaf when seen in April 1964. There is also reason to believe from evidence of dead branches and axillary growth that both this species and *D. stipulosa* do not die back completely each year.

Should the main stem be injured or removed a new stem is formed from the tuber crown at the appropriate growing season. In nature there is generally only one main stem per tuber, but the remains of one or more dead main stems are generally still attached to the crown. Very rarely in *D. cotinifolia* and *D. sylvatica* have two functional stems been found on the same tuber.

It is significant that persistent stems and renewal of growth from aerial buds occur not only in *D. mundtii* and possibly *D. burchellii* and *D. stipulosa* which are endemic to this temperate region, but also in *D. cotinifolia* and *D. sylvatica* which have a wider distribution. If the latter species behave similarly in the sub-tropical region it would seem that persistent stems might be of more widespread occurrence in other species of *Dioscorea* and have not been reported through lack of observation.

### *Tubers*

For lack of exact knowledge of the underground parts of many species it has generally been accepted that annual tubers are most common in the genus *Dioscorea* and that the solitary perennial tuber is rather exceptional. Of the eight species described here none have distinctly annual tubers and seven have a solitary perennial tuber. In the exceptional case, *D. cotinifolia*, there are a number of tubers which are formed singly at the ends of horizontal roots which arise from a perennial crown. This is apparently similar to the tuber system in *D. esculenta*, an edible Asian species of the *Combilium* section, now widespread in many parts of the world and to the system in the species of two other sections, *Madagascariensis* and *Cardiocapsa*, endemic to Madagascar. However all these species are said to have tubers which are replaced annually, whereas in *D. cotinifolia* tuber development does not seem to be completed within the year; for example in August there are present mature tubers up to 5 cm diameter,

juvenile tubers about 2 cm diameter and newly developing tuber-bearing roots which are just beginning to elongate but have not yet any swelling at their tips.

There is a fundamental difference also in the development of the seedling of the many tubered species as compared with those that have a solitary perennial tuber. In the seedling of *D. cotinifolia* the first tuber is a small swelling which is formed *laterally* with respect to the base of the first leaf (fig. 2). The leaf-base, presumably the hypocotyl/epicotyl region, forms the crown which in turn gives rise to horizontal roots, each terminating in a tuber. The development of the seedling in a species producing a solitary perennial tuber has been fully described by Sparshott (1935) who made a detailed study of *D. elephantipes*. Here the tuber is formed from the hypocotyl and in the seedling shows first as a small swelling immediately *below* the base of the leaf. Presumably the same type of seedling occurs in *D. hemicrypta*, another species with an epigeal perennial tuber and so similar to *D. elephantipes* as to be eligible for varietal rank. In *D. sylvatica*, the only other species in the section *Testudinaria*, the tuber is also developed immediately below the first leaf of the seedling (fig. 11).

It may be noted here that the final shape of the adult tuber in *D. sylvatica* is very dependent on the physical conditions of the soil. In loam it is uniformly disc-shaped with a few basal indentations and the growing point is below soil level. On scree slopes it may be subterranean, smooth skinned and variously misshapen by pressure against rocks. In shallow soils the tuber may be partially exposed and tessellated above and with irregular lobes in the lower section below soil level. In dune sand it is subterranean and may become enormous, up to a metre across, like a thick pancake with irregularly bifurcating lobes (fig. 10).

In the remaining species the tuber is subterranean, solitary and perennial and of an interesting branched form which does not appear to have been previously noted. Seedlings of *D. rupicola* and *D. mundtii* have been examined (figs. 4, 6) and the tuber appears as a small pyriform swelling immediately below the first leaf. It is remarkably similar at this stage to that of *D. sylvatica* and presumably is also developed from the hypocotyl. The upper part persists as a vertical crown and from the base one or two finger-like out-growths appear which produce a narrow, long-lived, sparsely branched tuber, covered by cork, increasing gradually over its whole periphery in thickness and elongating by apical growth. The vertical crown never comes above ground, in fact it is generally 9–10 cm below soil level in well developed plants, although elongating gradually from the apex which produces only one aerial stem at a time. The tubers of *D. burchellii* and *D. stipulosa* are essentially similar although smaller, with a much thinner layer of cork and generally more branched. Presumably the tubers of these two species are also developed from the hypocotyl. It may



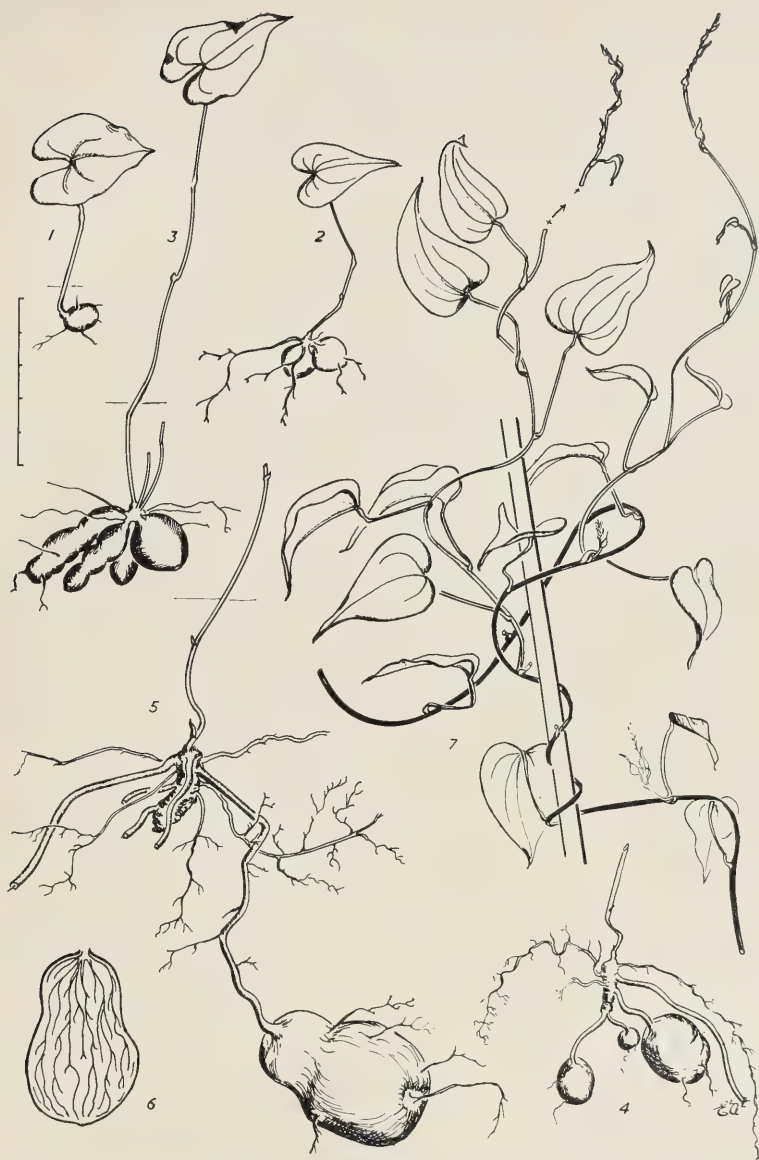


FIG. 2.

*D. cotinifolia*. 1—5 stages in development from seedling to young adult plant; 6 longitudinal section tuber; 7 renewal of growth in September from aerial stem of previous season (perennating stem shown in black). Scale = 50 mm.

be noted that in respect of *D. burchellii*, *D. mundtii*, *D. rupicola*, and *D. stipulosa* Burkill's key to the Old World sections of the genus breaks down as the tubers are perennial and the aerial shoot generally has more than three internodes buried between the crown and the soil surface.

### *Phylogeny*

The genus *Dioscorea* is a very large one with, according to Knuth (1924), over 600 species. Burkill is of the opinion that it is of tropical Indo-Chinese origin and that it had spread through Africa and was established in the southernmost regions prior to the Cretaceous splitting of the continents by the Atlantic Rift. This would have allowed species to reach South America both by migration from Northern Asia via North America and by separation from the African continent. At present it is not known whether the greater number of species occurs in Africa or in South America, each of which have more than the combined number of species in other parts of the world.

Burkill suggests that the earliest *Dioscoreas* showed sex separation with very little differentiation of the flower; they had twining stems, long-petioled gland-tipped leaves with a broad lamina and arcuate primary veins with reticulate intermediate venation; dispersal was by winged seeds released from a parchmency capsule. It appears that most species in high tropical forests have the seed completely surrounded by the wing or bilateral wings that are equally developed on either side of the seed, the former being considered the more primitive. Probably very early in the evolution of species more suited to sub-tropical conditions, there was a change in the form of the seed wing. At the present day many sub-tropical species have seeds winged only at one end, described here as proximally or distally winged according to whether the wing is directed towards the basal (proximal) or apical (distal) end of the capsule.

It is generally agreed that wing-type is a valid character by which sections within the genus can be distinguished and takes precedence over foliar and floral characters. To assist the subsequent discussion a diagrammatic comparison of wing-type for the relevant sections is given in Table II. The purpose of the discussion is to draw attention to the primitive or advanced characters of the eight species under consideration and to see if it is possible to place them in any phylogenetic relationship. At the same time it is proposed to examine the status of the solitary perennial tuber and to indicate, in spite of the meagre evidence available, that it is probably of very ancient origin. To begin with species occurring in fynbos or karoo vegetation will be excluded as being of more recent origin.

The most primitive form of wing-type in the eight species considered here is found in *D. rupicola* which has bilaterally winged seeds. This species occurs in the high forest of the Amatola Mountains at the limit of the mid-summer

Table 2.  
Diagrammatic comparison of some seed-wing and tuber characters in the genus *Dioscorea*.

















Wing	Tuber		Section	Species	Origin
		annual	Combilium Madagascariensis Cardiocapsa	<i>D. esculenta</i> <i>D. mamillata</i> <i>D. proteiformis</i>	cultivated Madagascar Madagascar
		? biennial	Cotinifoliae	<i>D. cotinifolia</i>	S. Africa
	?	armoured, ?solitary, ?perennial	Enantiophyllum (African spp.) Lychnostemnon	<i>D. rotundata</i> <i>D. ceratandra</i>	Sierra Leone Brazil
		solitary, ?perennial	Polyneuron	<i>D. cyphocarpa</i> <i>D. minima</i>	Mexico Mexico
	?	armoured, solitary, perennial.	Macroua	<i>D. sansibarensis</i>	Equatorial Africa
		solitary, perennial.	Rhacodophyllum	<i>D. rupicola</i>	S. Africa
		solitary, perennial.	Perennia	<i>D. mundtii</i> <i>D. burchellii</i> <i>D. stipulosa</i>	S. Africa



Table 2 (cont.)

Wing	Tuber		Section	Species	Origin
		annual	Brachyandra	<i>D. nako</i> <i>D. antaly</i>	Madagascar
		armoured, solitary, perennial	Testudinaria	<i>D. sylvatica</i> <i>D. elephantipes</i> <i>D. hemicrypta</i>	S. Africa

rainfall region. This is the most southerly point of its distribution, but it is not uncommon in Pondoland and Natal where other members of the South African section *Rhacodophyllum* are to be found. It has long petioles and very large lobed leaves with a conspicuous drip-tip; taken with the wing-type, this leads me to believe that it is the most primitive species in the area. It may be compared with *D. mundtii*, which is also a forest species but occurs in the all-season rainfall zone. On leaf characters the latter would appear to be more primitive than *D. rupicola* but the seed wing is very definitely proximal and on this basis it must be accepted as belonging to a different and probably more recent phylum than *D. rupicola*. In the case of *D. sylvatica* and *D. cotinifolia* the seed is distally winged. This indicates on wing structure alone that at least three ancient lines of development have been established in the area.

Let us turn now to consider how the form of the tuber affects the argument. It has already been shown above from the development of the seedling that there are two basically different modes of origin of the tuber. This immediately removes *D. cotinifolia*, with tubers of lateral origin, into a separate phylum from *D. sylvatica*, which has tubers of hypocotylar origin. Consequently it will be agreed that there are in fact four distinct phyla in the area.

To show that the two forms of tuber may be of very ancient lineage it is necessary to refer to species in other parts of the world, when it will be seen that these forms occur in species having the most primitive type of seed i.e. having the seed completely surrounded by the wing. Considering first tubers of lateral origin and referring to Table II, three species are given, *D. esculenta*, *D. mamillata* and *D. proteiformis* having tubers of this form. They belong to three different sections each of which is characterised by having the most primitive type of

seed completely surrounded by the wing. Whether the tubers are annual, biennial or perennial would be an independent later development, quite possible with this lateral type of origin, and capable of alteration in the evolution of new species. The laterally developed tubers then may well have originated prior to the development of the distally winged seed.

In the case of the solitary perennial tuber of hypocotylar origin it has been shown that the tubers of *D. rupicola*, *D. mundtii* and *D. sylvatica* originate in this way. Difference in shape is again a plastic character capable of alteration in the process of more recent selection. It was previously noted that on wing-type these three species belonged to three distinct phyla. Therefore it would seem that in having a tuber of similar origin, the type of tuber was initiated in the genus *before* the wing character started to change. If this is so species with the most primitive form of wing might also have tubers of hypocotylar origin. Unfortunately no relevant studies of germination are available to confirm this but it is permissible to prophesy that in species having a single perennial tuber it will eventually be found that the tuber is of hypocotylar origin. No clear picture of the presence of solitary perennial tubers in the genus has yet been published as the underground parts of many African and South American species are not known. Certain deductions can, however, be made. Burkill (1952) quotes African species of the section *Enantiophyllum*, the tropical African section *Macrourea* and the South American sections *Lychnostemon* and *Polyneuron* as having armoured tubers. Presumably this means that they are perennial and being solitary that they are very probably of hypocotylar origin. In *D. minima* (sect. *Polyneuron*) the form of the tuber as figured by Knuth (fig. 52 A, 1924) is very similar to that of a juvenile plant of *D. sylvatica*. In the section *Macrourea* the seed wing is bilateral and in the other three sections it is circular. If indeed the tubers in these sections is solitary and perennial and of hypocotylar origin, being associated with the most primitive wing-type it must have been evolved very early in the history of the genus. It also seems probable that the solitary perennial tuber was present in the southernmost part of the African continent in pre-Cretaceous times and had reached the South American continent prior to the Atlantic Rift.

The evidence given here is very slender and needs to be supported by anatomical investigation and a much wider comparison of the underground parts of different species. It does indicate however that the solitary perennial tuber may not have arisen from a rhizome according to Burkill's theory (1960 p. 346) and that De Bary's view (1877) that the *Dioscoreaceae* have three kinds of storage organs, namely swollen roots, rhizomes and tubers, is still tenable.

Turning now to speciation within the area under consideration it will be noted from the distribution records quoted for each species that five out of the

eight are endemic to the area. In the section Testudinaria, with distally winged seeds, *D. elephantipes* and *D. hemicrypta* are definitely denizens of the Karoo Flora. They are adapted to shallow soil in a semi-arid climate by having a perennial epigeal tuber which is well protected by thick cork and by the spiny remains of old shoots. Several growing points give rise to more than one shoot per season and have the ability to remain dormant in drought and to react quickly to unusual rains. The small glaucous leaves which fold upward about the mid-veins on hot days are deciduous in drought. The persistence of a remarkably well developed drip-tip is a feature worthy of future investigation. The development of these two species from the more widely distributed *D. sylvatica* is obvious, particularly in view of the highly plastic nature of the tuber in the latter species; subterranean with thin smooth skin in deep soils and partially exposed with corky tessellations on upper surface in shallow stony soils. Presumably *D. elephantipes* and *D. hemicrypta* have evolved comparatively recently within the Eastern Cape region and since the development of arid conditions during Pleistocene times.

The other three endemic species *D. mundtii*, *D. burchellii* and *D. stipulosa* agree in having proximally winged seeds, solitary perennial tubers of branched form, simple leaves, spike-like male inflorescences, globular buds, small receptacles, rotate flowers and six stamens. It has not been possible to place these species in any of the sections in Burkill's key to the Old World sections of the genus *Dioscorea* (1960), because their tubers are perennial, which, according to Burkill, would place them in the sections Borderea, Testudinaria or Macroura. This is quite incorrect as they have proximally winged seeds and many other contrary features. According to Knuth (1924) they are placed in the subsection Isocantha of the section Opsophyton, in which he includes such a manifestly different plant as *D. cotinifolia* and other unrelated species. Part of this confusion arises from the fact that the tubers of these species were hitherto unknown and such characters as left twining stems, simple alternate leaves and a spike-like male inflorescence with male flowers carrying six stamens were used in their assignation to sections.

I prefer to compare these three species with Burkill's Madagascan section Brachyandra (Burkill and Perrier de la Bâthie, 1950) in which the seeds are proximally winged, the buds globular, the perianth open (rotate or sub-rotate) and the stamens not grouped densely at the base of the flower. Indeed the leaves of *D. stipulosa* and *D. nako* are very similar while being unusual in the genus as a whole. But in the Brachyandra there are two tubers which are renewed annually from the lower part of a perennial corm. I consider that the presence of the solitary perennial tuber far outweighs the similarity of floral characters and also the presence of more superficial characters such as petaloid





FIG. 3.

*D. continifolia* 1—4 leaves from: main stem 4 ft. above ground, lateral just below canopy, mass of foliage in canopy (surface and side views); Male plant: 5 inflorescences, 6 buds, 7 longitudinal section flower, 8 dissection flower; Female plant: 9 inflorescences, 10 open flower, 11, 12 flower surface and sectional views, 13 branch of style; 14—16 stages in development of fruit; 17 longitudinal section capsule; 18 seed. Scale = 50 mm fig. 1—5, 9, 14—18; scale = 5 mm fig. 6, 10; scale = 2.5 mm fig. 7, 8, 12; scale = 1 mm fig. 13.

inclusions (cf *D. burchellii* and *D. acuminata*) or stipules and simple tubercles (cf *D. stipulosa* and *D. antaly*). I prefer to regard these three species as forming a separate section *Perennia* whose relationship with other African sections will be clarified when underground parts come to be better known and which, by virtue of its unusual geographical position, will probably be found to have a parallel development on the South American continent.

Within the group *Perennia* itself *D. mundtii* is obviously the most primitive species, having for example broad long-petioled leaves and flourishing in a forest margin environment. I consider it a relic species which may have some affinities with South American species. *D. burchellii* occurring in typical high growing Western Cape fynbos, which is a competitive community to forest in this area, is not a vigorous species. Its tubers are not well armoured and are liable to be eaten by tunnelling predators; female flowers are rare and fruit has so far not been recorded. Because of its great similarity to *D. stipulosa* in many other respects it is safe to assume that this species has proximally winged seeds. The few localities where *D. burchellii* has been reported are areas where afforestation with timber-producing pine trees is one of the main forms of land use and as it does not survive under these conditions it is now in danger of extinction through human activity. It may be regarded as one of the notable species evolved comparatively recently since Western Province fynbos has moved eastward into the transitional area of the Eastern Cape Province.

*D. stipulosa* is a plant of more vigorous growth than *D. burchellii*, the latter being distinguished by the scarcity of lateral branches, pendant male flowers, petaloid inclusions and paucity of stipules and tubercles. *D. stipulosa* grows in the drier less luxuriant fynbos of the summer rainfall area, at altitudes 4,000 ft. higher than *D. burchellii* and in communities where there are also present representatives of northern genera such as *Melanthus comosus* and *Leucosidea sericea*. It is a species which seems to be moving northwards to higher altitudes and for this reason might be considered as a more recent variation of *D. burchellii*. Nowhere common, it is also a species that might be easily overwhelmed if the mountain land where it occurs should be developed for intensive high altitude grazing.

From this brief study of eight species in the highly interesting transitional area west of East London, it emerges that the ancient genus *Dioscorea* of north-eastern origin is here represented by four distinct sections, two of which together contain five endemic species. Solitary perennial tubers, generally regarded as being poorly represented in the genus are here predominant. For the first time the natural occurrence of perennial or at least biennial stems giving rise to the new season's growth by means of dormant aerial buds is reported for the genus and is shown in the species *D. cotinifolia*, *D. sylvatica*, *D. mundtii*, *D. stipulosa*

and possibly also occurs in *D. burchellii*.

## KEY TO SECTIONS AND SPECIES.

1. Tubers several on roots from a perennial crown, stems dextrorse, seeds distally winged . . . . . *D. cotinifolia*  
(Sect. *Cotinifoliae*)
2. Tubers solitary, stems syntorse . . . . . 2.
2. Seeds bilaterally winged, leaf margins undulating, stamens three . . . . . *D. rupicola*  
(Sect. *Rhacodophyllum*)
- Seeds not bilaterally winged, leaf margins not undulating, stamens six . . . . . 3.
3. Seeds proximally winged, tuber with vertical crown and 1—3 basal branches, stems up to 2 mm diam. not tapering . . . . . 4.  
(Sect. *Perennia*)
- Seeds distally winged, tuber bunshaped, base entire or with bifurcating lobes, stem at base up to 20 mm diam. tapering . . . . . 6.  
(Sect. *Testudinaria*)
4. Stems ribbed, tuberculate . . . . . 5.
- Stems not ribbed, glabrous . . . . . *D. mundtii*
5. Male inflorescence pendant, leaves rarely with stipules . . . . . *D. burchellii*
- Male inflorescence erect, leaves stipulate . . . . . *D. stipulosa*
6. Stems branching at right angles, rigid, only twining in uppermost parts . . . . . 7.
- Stems not branching at right angles, lax, twining throughout length . . . . . *D. sylvatica*
7. Tuber with conspicuous lobes at base . . . . . *D. hemicypta*
- Tuber without conspicuous lobes at base . . . . . *D. elephantipes*

*Dioscorea cotinifolia* K. S. Kunth, Enum. pl. V, 386 (1850); R. Knuth, Pflanzenreich 87, IV. 43, 93 (1924) fig. 20 A–G; *D. malifolia*, Baker, Journ. Bot. XXVII, 1 (1889); Fl. Cap. VI, 248 (1896–97). Fig. 2 and 3.

*Plants* dioecious, upper leafy parts dying back seasonally and being renewed either from an axillary bud on the lower part of the aerial stem or *ab initio* from the perennial crown.

*Crown and Tubers.* In very young seedlings with a single leaf the hypocotyl epicotyl region is a small nodular swelling about 2 mm thick. This is the juvenile crown and gives rise to a laterally placed tuber up to 10 mm diam. The crown increases vertically by nodal growth giving forth fine branched rootlets, and thicker roots which terminate in a single tuber. Juvenile plants (with a shoot up to about 15 cm) bear up to 4 thick roots from 2–8 cm long, 2 mm diam, each terminating in a tuber 10–20 mm diam; tubers persist for more than one season; a few remains of old tuber-bearing roots persist attached to crown. Adult plants: crown about 3 cm below soil level, vertical, about 6 cm long, 1.5 cm diam, light creamy brown, gnarled; fibrous roots about 1 mm thick, wiry; tuber-bearing roots 4–6, up to 100 cm long, 1 cm or less diam, each terminating in a tuber; tubers globular or ellipsoidal, up to 9 cm long, 5 cm diam, outer skin light creamy brown, finely reticulate, soft, corky, without

“eyes”, inner flesh white, somewhat translucent, penetrated by numerous branching longitudinal opaque veins.

*Stem* solitary (very occasionally two), climbing, dextrorse, becoming much branched above in surrounding canopy at 3–4 metres, main stem and lower laterals may last more than one season, upper parts deciduous, growth commencing September either from axillary buds on aerial stem or from crown, lower parts with internodes up to 7 cm long, 2 mm diam, glabrous, wiry, brown or liver-coloured, bracts deltoid, about 2 mm long, apex subulate, leaves few; upper parts green, lax, creeping or pendant.

*Leaves* exstipulate, alternate, sometimes opposite, glabrous, deciduous, lower spreading, upper (in canopy) generally secund; lower pulvinus up to 7 mm long, about 1 mm diam, reddish-brown; petiole up to 25 mm long, less than 1 mm diam, olive-green, slightly channelled above, rounded below; upper pulvinus reddish-brown up to 5 mm long, scarcely thicker than petiole; lamina of juvenile leaves up to 4.5 cm long, 2.5 cm broad, deeply cordate, broadly ovate, sharply acuminate, acute; lamina of leaves from shaded lower part of adult plant up to 4.5 cm long, 3.7 cm broad, generally 7-veined, rounded or slightly cordate at base, broadly ovate, acuminate, obtuse, slightly mucronate; lamina of leaves from canopy spreading at right angles to incident light, folding upwards about mid-vein in great heat or drought, about 2.5 cm long, 2 cm broad, similar in shape to lower lamina, upper surface light yellowish-green, slightly glossy, veins and margins yellow, lower surface paler, matt, with concolorous veins.

*Male Flowers.* Inflorescences appearing October–December, racemes flexuous, erect, single or in axillary fascicles, rachis up to 14 cm long, pale green; flowers numerous, erect, solitary or in pairs; pedicels 1.5 mm or less; bract and bracteole deltoid, about  $\frac{1}{2}$ — $\frac{1}{3}$  length of pedicel, concolorous; buds obovate; perianth white, cup-shaped, about 5 mm diam; segments about 2 mm long, joined in lower quarter forming a shallow cup, outer spreading, slightly concave, obovate, obtuse, inner slightly more erect, oblong; stamens 6, inserted at base of segments, filaments less than half length of segments, white, incurved, anthers basifixed, introrse, pollen yellow; style a rudimentary, tripartite swelling from floor of receptacle.

*Female Flowers.* Inflorescence solitary, pendant, spike-like, hidden by leaves, rachis up to 10 cm long, green, elongating as fruit ripens; flowers up to 16, almost sessile, pendant; bract and bracteole ovate, acuminate, acute, slightly dentate, bract  $\frac{1}{2}$ — $\frac{1}{3}$  length ovary, bracteole shorter; buds globular; perianth greenish-white, cup-shaped, about 2 mm diam; segments about 1 mm long, equal, erect, incurved at tip, joined at base for about one third of length, broadly ovate, obtuse, concave; filaments rudimentary, less than 0.5 mm long,



attached to lower third of segments, anthers wanting; style cylindrical, about 0.5 mm long, 0.5 mm diam, style branches 3, spreading at right angles to style, apices decurved, acuminate, bi-lobed; ovary inferior, about 4 mm long, 1 mm diam, green, glabrous, longitudinally 3-ribbed, ribs rounded.

*Fruit.* Rachis remains pendant, pedicel thickens and elongates to about 2 mm, turning upwards bearing developing capsule erect; ripe capsule trilobular, three-winged, in side view turbinate terminating in globular remains of persistent perianth, up to 3 cm long, 2 cm broad at top, dehiscing from centre along ventral suture for about two-thirds of length, glabrous, light golden-brown with darker margins, ripening about July.

*Seeds.* 2 in each loculus, irregularly disc-shaped, dark russet-brown; wing distal, up to 14 mm long, 10 mm broad, russet-brown, membranous, rigid.

*Habitat.* Well represented in eastern coastal bush associated with *Schotia afra* and *Sideroxylon inerme*; becoming rarer westward and reaching its most westerly localities in the Bathurst Division at altitudes of about 50 ft. Also present in river bank bush with *Euphorbia triangularis* and in moister localities in low temperate forest at altitudes of 500 ft. Once recorded in such a locality in the Port Elizabeth Division. In Bathurst Division occurring in the same communities as *D. sylvatica*, in sandy loam over Bokkeveld Shale. The tubers are eaten by Bantu people in the Bathurst Division.

*Distribution.* TYPE, Cape Province, Kaffraria, Drege 4,500 (K) (probably between Bashee and St. John's River if sequence of numbers are a guide to locality).

CAPE PROVINCE. Port Elizabeth Division, van Stadens, Long 139 (AM); Bathurst Division, Port Alfred, Rogers no number 19/10/08 (AM), L. Britten 5111 (AM), Archibald no number 7/3/62, 7575 (AM, K, N), Rangemore Farm, Archibald 7535, 7536, 7537, 7538, 7539, 7540, 7546 (AM, K, N); King Williams Town Division, Acocks 12559 (N), Kei Road, Comins 1415 (AM); Komga Division, Schlechter 179 (AM), Flanagan 97 (AM); East London Division, Rattray 198 (AM), Nahoon, Smith 3735 (N), Need's Camp, Galpin 7100 (N). Also recorded eastwards in Natal and northwards in the Transvaal.

*Dioscorea rupicola* K. S. Kunth, Enum. Pl. V, 378 (1850); Baker, Fl. Cap. VI, 249 (1896-97); R. Knuth, Pflanzenreich, 87, IV. 43, 186 (1924) fig. 38 A-J. Fig. 4 and 5.

*Plants* dioecious, aerial stem dying back seasonally and being renewed from the tuber-crown.

*Tuber* perennial, hypogaeal; in juvenile plants pear-shaped, formed at base of first leaf, presumably of hypocotylar origin, up to 15 mm long, 10 mm diam at base, the apex forming the crown, the base developing a finger-like tuber; in adult plants crown cylindrical, vertical, up to 4 cm long, 4 cm diam, up to 15



FIG. 4.  
*D. rupicola*. 1 Seedling; 2 juvenile plant; 3 adult tuber; Male plant: 4 inflorescences, 5 bud,  
 6 flower in surface and sectional views. Scale = 50 mm fig. 1—4; scale = 5 mm fig. 5—7.

cm below soil surface, sides irregularly ribbed, corky, apical growing point slightly convex with hard, brown, deltoid bracts up to 15 mm long, with remains of 2–3 decaying basal parts of previous shoots; tuber of 1–3 branches from base of crown, up to 30 cm long, irregularly rhomboidal in transverse section, up to 1 cm broad at top, 3 cm broad at base, 3 cm thick, base with irregularly lobed margins giving rise to numerous wiry roots, outer parts dark-brown or black, tough, corky, fissured, inner tissue white, brittle.

*Stem* solitary, climbing, sinistorse, becoming branched above on emerging on sides of forest shrubs, reaching height of approx. 3 metres, growth commences in late spring (late October); underground portion of stem whitish, twisting unevenly to avoid obstructions; bracts deltoid, up to 6 mm long, 3 mm broad at base, apex beak-like, recurved; aerial stem cylindrical or slightly angular, up to 4 mm diam, finely ribbed, brown or liver-coloured, with greenish linear markings up to 5 mm long, glabrous, lowermost internodes about 2.5 cm long, upper internodes up to 10 cm long, somewhat fleshy, lax.

*Leaves* exstipulate, alternate, bifacial, glabrous, deciduous; lower pulvinus conspicuous, variously twisted to present upper surface of lamina at right angles to incident light, generally lighter in colour than stem, broadly cordate at base, thicker than petiole, gradually tapering upwards into petiole, up to 8 mm long; upper pulvinus slightly thicker and paler than petiole, widening above to merge with lamina; petiole of adult leaves concolorous with stem, glabrous, finely ribbed with narrow channel on adaxial surface, 1.5–7 cm long, up to 2 mm diam; lamina of seedling leaves very broadly ovate, up to 5 cm long, only slightly longer than broad, deeply cordate, sinus acute, auricles about one-third length of lamina, 7-veined, margins entire or very slightly indented, apex acute; lamina of leaves of juvenile plants ovate, about 3.5 cm long, 2.2 cm broad, auricles about one-fifth length, sinus less acute, occasionally with slight lateral lobes, apex acute; lamina of mature leaves hastate, 5-lobed or occasionally 7-lobed, slightly longer than broad, very variable in size, the largest leaves frequently subtending well developed ♂ or ♀ inflorescences, up to 14 cm long, 11 cm broad, central lobe deltoid, acuminate, acute, slightly mucronate, lateral lobes rounded, sinus obtuse, rounded, margins undulating, indented, upper surface dark, glossy green with depressed veins, under surface duller, paler, with prominent veins.

*Male Flowers.* Inflorescences appearing early in November. Racemes solitary, simple, spike-like, up to 8 cm long, erect or twisting into an erect position if shoot pendant, not hidden by leaves, with up to about 30 sessile flowers; buds turbinate, acute, initially erect; flowers solitary, pendant, with a light, sweet scent; bract and bracteole linear, slightly broader at base, a half to one-third length of perianth, glabrous; perianth campanulate, segments about one and a

half times as long as fleshy receptacle, joined at base for about one-sixth of length, slightly spreading, yellowish-green on both sides, ovate-lanceolate, about 4.5 mm long, 1 mm broad at base, fleshy, margins entire, apex acute, inflexed; stamens characteristically 3, filaments arising between the base of the segments and the inner fleshy disc, up to 1.5 mm long, slender, cream, anthers bilocular, introrse, dorsifixed, yellow, about half as long as broad; staminodes wanting; disc thick, fleshy, about 2 mm diam, rounded on top with three slightly raised portions alternating with stamens, hollow in centre, reddish-pink; style absent.

*Female Flowers.* Inflorescence solitary, pendant, spike-like, hidden by subtending leaf, rachis up to 10 cm long, with up to 16 almost sessile flowers; flowers spreading or somewhat erect; buds turbinate, pendant, acute; bract and bracteole acuminate, acute, about one-seventh length of ovary, whitish-green; perianth rotate when fully open, more frequently appearing campanulate due to partial closure, about 10 mm diam, yellowish-green; segments lanceolate, acuminate, almost free, about 4 mm long, 1 mm broad at base, fleshy, margins entire, apex acute, inflexed with a small slightly red-coloured tubercle on dorsal side; staminodes 3, erect on margin of disc, less than 0.5 mm. long, anthers rudimentary; disc fleshy, about 2 mm diam, flat on top, depressed in the centre, green with a spot of red opposite each staminode, becoming pale maroon in older flowers; style cylindrical, about 1 mm long, upper part 3-branched, branches recurved at right angles to style and about half its length, apices opening vertically into bi-labiate stigmatic surfaces; ovary inferior, green, pendant but assuming lateral or nearly upright position as flower opens, 8–10 mm long, about 2 mm diam, joined to flower by pseudopedicel about 0.5 mm long, tri-locular, in transverse section triangular with rounded angles and rib protruding on middle of each side, when seen longitudinally with a raised rib running down each side, glabrous, with two ovules borne about half-way up each loculus.

*Fruit.* Rachis remains pendant, pedicel thickens and elongates, twisting upwards and bearing developing capsule erect, when ripening each cluster of fruit hidden by subtending leaf; ripe capsule up to 3 cm long, 1.5–2 cm broad, broadly ovoid, triangular, three-winged, smooth, slightly glossy, light brown, terminated by persistent dry perianth, dehiscing early in May.

*Seeds.* Two in each loculus, circular, flat, 6 mm diam, wing bilateral, membranous, reddish-brown, up to 20 mm long, 8 mm wide.

*Habitat.* This species occurs at altitudes of 4,000 to 5,500 ft on shady eastern and southern slopes in moist black doleritic soils formed under temperate rain forest in which *Podocarpus falcatus* and *Olea capensis* are common. It grows as a creeper on marginal shrubs at edge of forest or in clearings, generally where dolerite boulders are lying and it is to this the specific epithet probably refers.

*Distribution.* TYPE. Cape Province, Ecklon and Zeyher (fide Knuth) Hort.



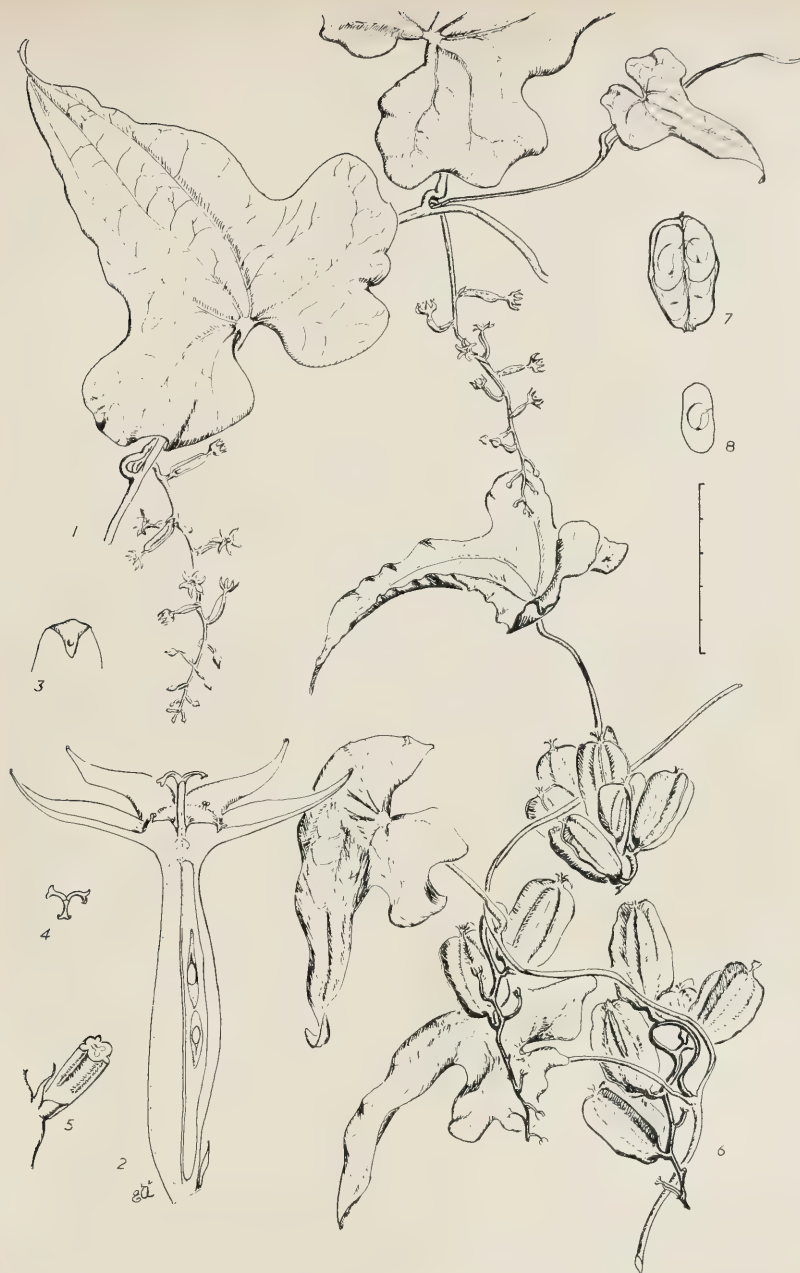


FIG. 5.

*D. rupicola*. Female plant: 1 inflorescence; 2 flower sectional view, 3 tip of segment, 4 style branches, 5 ovary with end in sectional view; 6 ripe fruit; 7 capsule in sectional view; 8 seed. Scale = 50 mm fig. 1—6; 8, scale = 10 mm fig. 5, scale = 5 mm fig. 2, 4; scale = 2 mm fig. 3.

Berol., (duplicates Hb. Petrograd 3.21.12 and Royal Botanic Gardens, Kew). Note: Ecklon left the manuscript name *Testudinaria rupicola*, which was adopted by K. S. Kunth in naming the species. Ecklon and Zeyher explored the upper reaches of the Kat River Valley about 1830, a region about 20 miles north-west as the crow flies from the Hogsback, which is one of the most westerly of the present day localities of the species.

CAPE PROVINCE: Drege 4498 (no specific locality); Fort Beaufort Division, Hogsback, Acocks 11019 (N), Archibald 7551, 7552, 7557, 7558, 7560 (AM, B, K, N), Barker 1997 (NBGK), Hill 3139 (RU), Johnson 1273 (AM, N), Noel 304, 8563 (RU); Stutterheim Division, nr. Frankfort on Stutterheim Rd. Comins 1425 (AM). Also recorded from Transkei, Pondoland, Natal and Swaziland.

*Dioscorea mundtii* Baker, Journ. Bot. XXVII, 1 (1889); Fl. Cap. VI, 248 (1896-97); R. Knuth, Pflanzenreich, 87, IV, 43, 94 (1924) fig. 20 H. Fig. 6 and 7.

*Plants* dioecious, with upper leafy parts dying back seasonally and being renewed either from an axillary bud of the aerial stem or from the tuber-crown.

*Tuber* perennial, hypogaeal; in seedling pear-shaped, formed at base of first leaf, presumably of hypocotylar origin, up to 10 mm long, 7 mm diam at base; in juvenile plants crown cone-shaped, about 3 cm long, about 2.5 cm diam at base, sides longitudinally ribbed, basal margin undulating giving rise to one or two finger-like branches, about 5 cm long, 0.7 cm thick. In adult plants crown up to 15 cm below soil level, vertical, cylindrical, about 5 cm long, 2.5 cm diam, upper part formed of enlarged, corky bracts; tuber branches generally two, horizontal or coiled round roots or stones, occasionally branching dichotomously, up to 35 cm long, rhombic in transverse section, up to 2 cm broad on top, base up to 4 cm broad, with undulating margins, producing strong wiry roots about 1 mm diam, outer skin hard, corky, black, with irregular cracks, inner flesh white, brittle. Tubers, when eaten by predators, protect the wound by cork formation and are apparently capable of forming a new growing point if original is damaged.

*Stem* solitary, climbing, sinistrorse, much branched above, upper part deciduous, main stem and lower laterals may persist more than one season, a new shoot is formed late in January or February, from the crown if the main stem dies right back, or from several axillary buds of the aerial stem up to about 3 metres above ground; subterranean parts of stem yellowish-white, irregularly swollen up to 4 mm thick, nodes with lanceolate-acuminate bracts up to 7 mm long; aerial stem up to 2 mm thick, glabrous, smooth, dull green to liver-brown, climbing up to about 5 metres, with trailing or pendant laterals.

*Leaves* exstipulate, alternate, bifacial, glabrous, deciduous; lower pulvinus up to 5 mm long, 2 mm diam at base, narrower above, brownish-green; upper pulvinus very slightly thicker than petiole, about 1 mm long; petiole up to

30 mm long, 1 mm diam, channelled above, rounded to slightly ribbed below, twisted, olive- or brownish-green; lamina of seedling, juvenile and adult plants essentially similar in shape, broadly ovate, acuminate, slightly mucronate, deeply cordate with auricles up to one quarter total length, seedling lamina 3·5 cm long, 2·5 cm broad, adult lamina up to 9·5 cm long, 8 cm broad, horizontal or somewhat pendant, 7-veined, upper surface slightly glossy, pale yellowish-green, veins somewhat depressed, margins entire, lower surface duller, darker, veins and margins somewhat protruding. Leaves subtending male inflorescences are twisted away from the spike, those subtending female inflorescences are much larger and hide even the ripening clusters of fruit.

*Male Flowers.* Inflorescences appear in April, racemes single or in axillary fascicles, erect, simple or sparingly branched, up to 10 cm long, pale green; flowers numerous, single or in small clusters; pedicels 0·5 mm or less; bract and bracteole, greenish-cream, 0·5 mm or less, broadly ovate, bract acute, finely mucronate, bracteole shorter, obtuse; buds globular, erect; perianth pale greenish-cream, funnel-shaped, 4·5 mm diam; segments about 2·5 mm long, less than 1 mm broad, lower third joined, free above, ovate, outer deflexed, inner spreading, straight, margins deflexed; stamens six, outer attached to lip of cup, inner slightly lower, filaments less than 1 mm long, incurved, white, anthers introrse, dorsifixed, pollen yellow; style rudimentary, tripartite, cone-shaped, about half length of perianth cup.

*Female Flowers.* Inflorescence solitary, pendant, up to 8 cm long, pale green, with up to twelve very shortly pedicellate flowers; bract and bracteole, about 1 mm long, ovate, acuminate, concolorous with ovary; buds ellipsoidal, pendant; perianth greenish, rotate, about 3·5 mm diam; segments equal, about 2 mm long, joined at base for about one-third of length, elliptical, acute; stamens rudimentary, joined to lip of perianth, filaments minute, incurved, green, anthers nodular swellings; style about 1 mm long, slender, cylindrical, branches three, spreading at right angles to style, about 0·5 mm long, apices flared, bilobed, lobes folded downwards; ovary inferior, about 5 mm long, about 1 mm diam, joined to perianth by 1 mm long pseudo-pedicel, narrowly elliptical, green, longitudinally 3-ribbed, glabrous.

*Fruit.* Rachis remains pendant, pedicels thicken and elongate to about 3 mm, turning upwards and bearing developing capsules erect; ripe capsules trilocular, three-winged, in side view oblong, up to 3·5 cm long, 1·5 cm wide, light biscuit-coloured, smooth, dehiscing from apex for about one-quarter of length, shedding seeds from December onwards.

*Seeds* two in each locus, flat, almost circular, up to 7 mm diam, dark-brown; wing proximal, membranous, light-brown, up to 20 mm long, 7 mm wide.

*Habitat.* A coastal species with distribution apparently restricted to the

George and Knysna Divisions it occurs on fixed dunes, from about 10 feet above sea level, under bush which forms a 10 to 15 ft canopy. Common species of this community are *Sideroxylon inerme*, *Rhus* sp., *Cassine* sp. and *Brachylaena elliptica* which with other species gives rise to a thick litter covering dark-brown loamy sand which overlies pale dune sand to a depth of about 25 cm. *D. mundtii* also occurs on the margin of temperate forest bordering the escarpment behind the dunes. Here *Podocarpus falcatus* is dominant and the soil is a reddish brown loam. This coastal region has a rainfall of about 45 inches per annum and is frequently covered by heavy sea mists.

*Distribution*: TYPE. Cape Province: Without locality, Mundt (K). Knysna Division, Koratra, below 1,000 ft J. F. Drège 8559 (K). Leopold Mundt of Berlin came to Cape Town as a chemist and was commissioned by the Prussian Government to collect plants, in this he was assisted by his gardener Maire. He visited George Rex in the Knysna District. Apparently he was rather profligate and his stipend from Prussia was withdrawn. "Two wagon loads" of his specimens were sent back to Germany in 1822 on the same ship as the first specimens collected by C. F. Drège. The name he appended to his herbarium specimen of this species was *Teschidinaria nemorum* (of the woods) which shows he was impressed by the forest in which he must have found it.

CAPE PROVINCE. George Division, Wilderness Forest, Compton 10683 (NBGK), Kaaiman's Gat, Archibald 7561/a (AM), Fairy Knowe, Archibald 7583 (AM), 8004 and 8005 (AM, K, N); Knysna Division, Groot River, Fourcade 1232 (B), Groot River, Blue Rocks, Archibald 7559 (AM), 7560 (AM, K, N), 7561 b (AM) 7564 (AM), Groot River, Natures Valley, Archibald 7569 and 8003 (AM, K, N).

*Dioscorea burchellii* Baker, Journ. Bot. XXVII, 1 (1889); Fl. Cap. VI, 247 (1896-97); R. Knuth, Pflanzenreich 87 IV. 43, 94 (1924). Fig. 8.

*Plants* dioecious, leafy shoot dying back periodically and being renewed from the tuber-crown or possibly from a persistent portion of the aerial stem.

*Tuber* perennial, hypogeal; seedlings not seen. Juvenile plants with shoots up to 30 cm long and withered remains of up to six previous shoots, have conical crown up to 5 mm long, 5 mm diam at base, lower part of tuber with 1-3 horizontal, cylindrical branches up to 25 mm long, 5 mm diam, with thin brown outer skin and numerous fine fibrous roots. In adult plants crown vertical, up to 30 mm long, 25 mm diam, lower part with up to four horizontal branches up to 90 mm long, 30 mm thick, angular, irregularly twisted, outer skin corky, blackish-brown, finely and irregularly reticulate, inner flesh white, hard, brittle. Tubers eaten by small tunnelling predators (? small moles), if growing point injured a secondary growing point may form from another portion of the tuber.





FIG. 6.

*D. mundtii*. 1 Seedling; 2—4 stages in development of juvenile plant; 5 adult tuber from Kaaiman's Gat with dead shoot of previous season and two new shoots forming (mid-January). Scale = 50 mm.

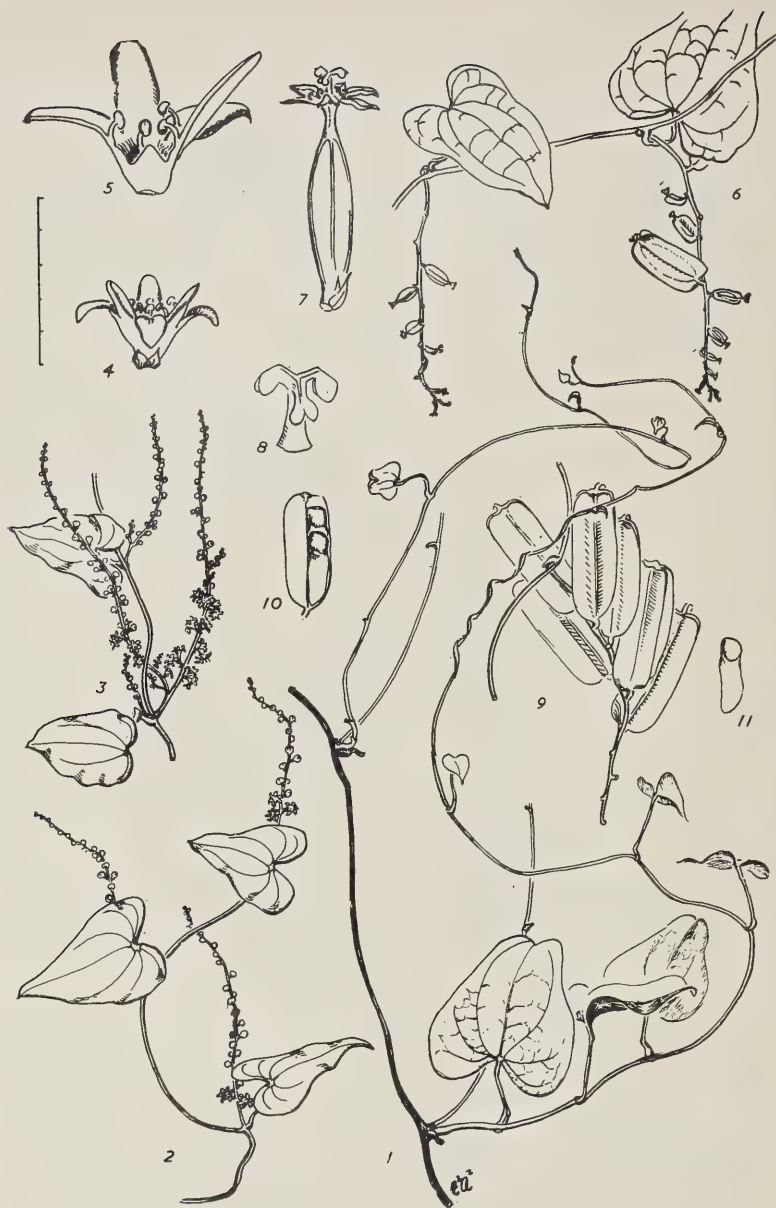


FIG. 7.

*D. mundtii*. 1 Portion of aerial stem showing regeneration from axillary buds (perennating portion shown in black); Male plant: 2, 3 simple and compound inflorescences, 4, 5 flowers in side and sectional views. Female plant: 6 inflorescences, 7 flower, 8 style branches; 9 ripe capsules; 10 longitudinal section of capsule; 11 seed. Scale = 50 mm fig. 1—3, 6, 9—11; scale = 10 mm fig. 7; scale = 5 mm fig. 4; scale = 3 mm fig. 5; scale = 2 mm fig. 8.

*Stem* solitary, climbing, sinistrorse, sparingly branched, upper part deciduous, regeneration from lower part of aerial stem probable but not definitely observed, growth commencing December–January; subterranean portion irregularly swollen, up to 4 mm thick, whitish, nodes up to 4 cm long, bracts minute; basal parts of aerial stem leafless, partially prostrate, wiry, 1–2 mm thick, internodes 4–5 cm long, finely ribbed, smooth or slightly scabrid, with black spots or small yellowish tubercles, bracts up to 2 mm long, swollen at base, hard, with recurved beak-like apex occasionally with small inconspicuous stipules; leafy portion of stem climbing to height of about 2 metres, dark greenish-brown.

*Leaves* alternate, bifacial, glabrous, deciduous, generally exstipulate but occasionally with very inconspicuous stipules less than 1 mm long at base of earlier formed leaves; lower pulvinus up to 2 mm diam, slightly scabrid or tubercular; upper pulvinus not clearly differentiated from petiole, smooth; petiole up to 15 mm long, pale brownish-green, finely ribbed, channelled above, occasionally slightly scabrid; lamina pendant, in basal leaves of juvenile plants broadly ovate,  $10 \times 10$  mm, to ovate  $20 \times 15$  mm, cordate, sinus generally acute, apex obtuse to acute, apiculate, in leaves of adult plants ovate,  $32 \times 13$  mm, to narrowly ovate,  $44 \times 8$  mm, with slightly cordate or rounded base, if cordate sinus very shallow, occasionally with slight basal lobes, 5–7-veined, pliant, soft, acuminate, apex apiculate, occasionally slightly mucronate, upper surface dark matt green with lighter spots, raphides present in lamina and petiole, under surface paler, margins entire, slightly decurved. In only plant seen with female flowers leaves were consistently of the long narrow shape, other plants with similarly shaped leaves were flowerless at the time of observation.

*Male Flowers.* Inflorescences present April–June, racemes single, *pendant* simple or very occasionally with lowest node subtending a cluster of flowers, up to 30 mm long, pale green; flowers pendant, up to 12 in number, very shortly pedicellate; bracts and bracteole concolorous with perianth, ovate, acute, less than 1 mm long; buds globular pendant; perianth creamy-white, saucer-shaped, almost rotate, 5–6 mm diam, persistent when dry; segments elliptic, up to 3 mm long, 1 mm broad, joined for about one-third of length, outer spreading, inner slightly shorter, incurved, margins entire, apex obtuse, minute concolorous granules are present in perianth tissue, more numerous in lower half of segments, conspicuous as liver-coloured streaks in dry persistent flowers of type; stamens six, outer attached to lip of perianth, inner slightly lower down, filaments incurved, about 1 mm long, white, anthers introrse, pollen yellow; style vestigial, slightly convex, indefinitely tripartite.

*Female Flowers.* Inflorescence (only one example seen) pendant, simple, 30 mm long, pale green; flowers two, sessile, pendant; bracts and bracteole

subtending each flower, green, bract lanceolate, less than 1 mm long, bracteole linear, shorter; buds globular; perianth ? greenish-white, cup-shaped (fully open flowers not seen); segments equal, joined in lower third, ? about 1 mm long, 0.8 mm wide; stamens rudimentary, attached to lip of perianth cup, filaments white, minute, anthers bilobed; style cylindrical, about one-third length of segments, white, erect, style branches three, spreading at right angles to style, apices flared, bilobed; ovary inferior, 3 mm long in bud, about 1 mm diam, green, glabrous, longitudinally three-ribbed.

*Fruit and Seed* not seen.

*Habitat.* Growing at altitudes of 600—1,500 ft. on south facing quartzitic slopes in moist black sandy soil following lines of drainage. *D. burchelli* occurs in very dense fynbos communities where bushes may reach a height of 12 ft or more and where *Protea neriifolia* is one of the commonest plants together with species of *Restio*, *Thamnochortus*, *Indigofera*, *Leucodendron* and *Erica*. Its shoots may climb about three-quarters of the way up the surrounding vegetation but although flowering, have not been seen to reach the top. They are thus not exposed to direct sunlight. The tubers are very thickly surrounded by the roots of other plants as the community is so dense.

*Distribution.* TYPE. Cape Province. George Division, Forest near Touws River, Burchell 5728 (K).

CAPE PROVINCE: George Division, Woodfield, Archibald 7582, 7584, 7591, 7592 (AM, K, N) 7587, 7585 (AM); Knysna Division, Concordia Plantation, Keet 666 (AM, N), Mrs Dalgairns s.n. (AM); Uniondale Division, Prince Alfred Pass, Fourcade 1272 (B); Humansdorp Division, Karreedouw Pass, south side, Fourcade 1175a (B), Hankey, Fourcade s.n. (on same sheet as Fourcade 1272, (B)), Assegai Bosch, Thode 2577 (N). Without locality, Mund and Maire s.n. (as quoted by R. Knuth, but not seen by author). A male plant has been cultivated for a number of years by Miss Grace Britten at Albany Museum Herbarium Garden, locality unknown, herbarium specimen Archibald 7563b (AM).

*Dioscorea stipulosa* R. Knuth (ex Uline msc), Pflanzenreich 87, IV. 43, 94 (1924). Fig. 9.

*Plants* dioecious, leafy shoot dying back periodically and being renewed either from crown of tuber or possibly from an aerial bud if shoot does not die back completely.

*Tuber* perennial, hypogeal. Seedlings not seen. In adult tubers crown up to 25 cm below soil surface, cone-shaped, vertical, up to 50 mm long, 15 mm diam, apex with remains of old shoots, lower part with one or more finger-like, horizontal branches, up to 80 mm long, 15 mm thick, outer skin dark-brown, hard horny, inner flesh very compact with pale yellowish tinge; roots thin, wiry.



*Stem* solitary, climbing, sinistorse, upper part freely branched, deciduous, lower part possibly persisting for more than one season or renewed *ab initio* from crown, growth commencing October–November; subterranean part with internodes 4–5 cm long, not swollen, with conspicuous ovate-acuminate bracts up to 6 mm long, 2 mm thick at base; aerial stem climbing to height of about 3 metres, internodes up to 10 cm long, up to 2 mm thick, dark-brown, tough, wiry, strongly ribbed, scabrid, with numerous concolorous or black tubercles; bracts on lower part of stem rhombic, acuminate, beaked, rigid, ribbed dorsally, tubercled, with stipular outgrowths up to 1 mm long.

*Leaves* alternate, bifacial, glabrous, deciduous, stipulate; stipules simple or compound, persistent, subulate, up to 1 mm long, inconspicuous on leaves of ultimate laterals; lower pulvinus greenish-brown, up to 2 mm long, concave above, swollen laterally and dorsally, ribbed, scabrid, generally tuberculate; upper pulvinus inconspicuous; petiole about 1 mm diam, up to 15 mm long, deeply channelled on upper surface, rounded and ribbed below, twisted or straight, erect or spreading, occasionally sparsely tuberculate, concolorous with stem; lamina spreading at right angles to incident light, stiff, brittle, 5–7 veined, base rounded or cordate with obtuse sinus, not lobed, lower shade leaves broadly ovate, up to  $45 \times 40$  mm, upper leaves ovate, very variable in size, up to  $45 \times 18$  mm, upper surface dark green, matt, veins somewhat depressed, stomata absent, undersurface paler green with prominent yellowish veins and margins, stomata present, raphides absent, apex acute or obtuse, mucronate, mucro up to 1 mm, occasionally slightly longer.

*Male Flowers.* Inflorescences present December–January, occasionally flowers solitary (on young laterals), generally raceme well developed, simple or with short lateral branches, rachis up to 8 cm long, *erect*, pale green, persistent when dry; flowers up to 20 in number, erect or patent, pedicel up to 1 mm long; bracts 2, lanceolate, lower about 1 mm long, upper about half as long, concolorous with perianth; buds globular, erect; perianth cream, funnel-shaped, 3–4 mm diam, persistent; segments about 3 mm long, 1 mm broad, lower third joined, outer spreading elliptic, acuminate, acute, inner incurved, margins reflexed, somewhat concave in centre, apex obtuse, tissue without granules; stamens 6, outer inserted on lip of tube, inner slightly lower, about two-thirds length of segments, incurved, anthers basifixed, introrse, pollen yellow; style a rudimentary swelling on floor of receptacle.

*Female Flowers.* Inflorescence pendant or spreading, rachis simple, ribbed, up to 7 cm long; flowers up to 10 in number, inconspicuously pedicellate, patent; bract lanceolate, narrowly acuminate, up to 3 mm long, bracteole about half length of bract, pale green; buds globular; perianth rotate, pale green, about 4 mm diam; segments about 2 mm long, joined for about one-quarter of length



FIG. 8.

*D. burchellii*. 1 Juvenile plant; 2 adult tuber with current season's shoot and remains of previous shoots; 3 bract near base of main stem; 4 base of leaf subtending male inflorescence; Male plant: 5 portion of Type, Burchell 5728, 6 inflorescences, 7, 8 flowers in surface and sectional views, 9 Burchell 5728 and 10 Archibald 7591 (flowers shaded to show petaloid inclusions); Female plant 11 inflorescence, 12 flower. Scale = 50 mm fig. 1, 2, 5, 6; scale = 25 mm fig. 3, 4, 7—10; scale = 2 mm fig. 12.

at base, ovate-lanceolate, acute, with median vein; stamens 6, rudimentary, joined to segments about one third from base, filaments incurved, anthers glo-bular; style cylindrical, about 0.5 mm long, style branches 3, horizontal, slightly thinner and shorter than style, apices bilobed, deflexed; ovary inferior, about 5 mm long, 1 mm diam, narrowing towards base, green, glabrous, longi-tudinally ribbed, trilocular, triangular in cross section.

*Fruit.* Rachis becomes *erect* as fruit ripens, pedicels thicken, elongating to about 5 mm; capsules erect, winged, up to 2.5 cm long, 1.5 cm broad, elliptical or oblong-elliptical, terminated by persistent perianth, smooth, light yellowish-brown, with minute brown spots, ripening in April.

*Seeds* two in each loculus, flat, circular, about 5 mm diam, wing proximal, variable in size, up to 12 mm long, 6 mm wide, russet-brown, membranous.

*Habitat.* Growing on south facing slopes beside streams or in line of seepage in moist black soil derived from dolerite. *D. stipulosa* occurs in low fynbos about 3 ft high composed of species of *Anthospermum*, *Cliffortia* and *Indigofera*, or in low, 10 ft, riverine bush containing species of *Leucosidea*, *Rhus* and *Melanthus*.

*Distribution:* TYPE. Cape Province, without locality, Ecklon and Zeyher, 4.47.5. (Mus. bot. Berol). (Photo only seen). (Ecklon and Zeyher 4.47.5 at Kew is "probably a duplicate of the holotype" fide E. Milne-Readhead.) Note: Ecklon and Zeyher collected in the divisions of Fort Beaufort and Bedford. CAPE PROVINCE: Fort Beaufort Division, Tor Dun, Hogsback, Archibald 7554, 8002 (AM, K, N), Hogsback, Rattray 70 (AM), Johnson 1160, 1299 (AM), Noel 11051, 12179, 8562 (RU), Archibald 5911 (AM); Bedford Division, Killick (AM, N); "British Kaffraria" Barber 34 (AM).

*Dioscorea sylvatica* Ecklon, S. Afr. Quart. Journ. I, 363 (1830). For full literature and synonymy see Burkill, Journ. S. Afr. Bot. 18, 188 (1952). Fig 10 and 11.

*Plants* dioecious, upper leafy parts dying back seasonally and being renewed either from the crown or, if the aerial stem persists, from aerial buds.

*Tuber* perennial, hypogeal or with up to one-third exposed; in seedling globular or pyriform, formed at base of first leaf, presumably hypocotylar in origin, up to 10 mm diam; in juvenile plants broadening at base becoming bun-shaped, with short, conical crown. In adult plants crown inconspicuous, marked by few persistent bases of old shoots and by membranous, deltoid, brown bracts about 1 cm long; tuber varying in size and shape according to physical conditions of terrain, in coastal dune sand with crown 25 cm or more below soil surface, about 12 cm thick, up to 1 metre diam, margin irregular with deeply incised, bifurcating lobes which may overlap, outer skin dark brown, corky, hard, finely and irregularly reticulate; on shallow soils or rocky slopes irregularly lenticular, up to 20 cm thick, up to 40 cm diam, up to 9 kg

in weight, crown and upper third exposed, with brownish-grey, hard, corky, 4- to 7-sided shields up to 10 mm thick, up to 40 mm across, subterranean part, finely reticulate, corky; in deep forest soils hypogeal, lenticular, outer skin finely reticulate, corky; on loose scree slopes 20 cm or more below surface, misshapen by pressure against stones, outer skin grey, about 2 mm thick, smooth inner flesh in all cases white, brittle; roots thin, fibrous, from base of tuber only.

*Stem* solitary, very occasionally more than one, climbing sinistorse, much branched above, deciduous or main stem and lower laterals persisting for more than one season, growth commencing August-September; lower part up to 1 cm diam, glabrous liver-coloured with grey or greenish-grey markings; bracts deltoid, clasping stem, up to 8 mm broad at base, up to 4 mm thick; upper part of stem about 2 mm thick, dull-green to liver brown, climbing to height of 15 metres, ultimate laterals trailing or pendant.

*Leaves* exstipulate, alternate, sometimes opposite, bifacial, glabrous, deciduous; lower pulvinus up to 7 mm long, 2—3 mm diam at base, tapering above, slightly channelled on upper surface, frequently twisted bring upper surface of lamina at right angles to incident light, brownish-green; upper pulvinus 2—3 mm long, equal in thickness to petiole; petiole up to 25 mm long, 1 mm or less diam, lower surface rounded, upper surface slightly channelled, green, glabrous; lamina in seedlings very broadly ovate, obtuse,  $21 \times 20$  mm, to ovate, acuminate, acute,  $22 \times 15$  mm, cordate, sinus acute, auricles sometimes overlapping, up to one-quarter of total length, mucro less than 1 mm; lamina in juvenile plants ovate, acuminate, acute,  $40 \times 30$  mm, cordate, auricles up to 10 mm, sinus acute, mucro thread-like, 1—2 mm long; in adult plants lamina of lower leaves generally largest, very variable, broadly ovate, acuminate, acute, up to  $75 \times 63$  mm, acutely cordate, auricles 25 mm, or hastate, obtuse, up to  $60 \times 60$  mm, obtusely cordate, auricles up to 28 mm rounded; in lateral shoots bearing inflorescences lamina hastate, obtuse,  $24 \times 17$  mm, obtusely cordate, auricles about 6 mm, rounded, upper part somewhat oblong, less than 8 mm wide for more than half total length, plants with hastate leaves may also show additional lobing opposite second pair of veins, leaves in any one plant very variable in size, frequently larger leaves subtend the main inflorescences; upper surface smooth, slightly glossy, yellowish-green becoming dark green, in eastern districts at higher altitudes sometimes glaucous; lower surface not shining, paler green, veins and margins somewhat prominent; mucro subulate, deltoid, up to 4 mm long, 1 mm thick; occasionally apex emarginate.

*Male Flowers.* Inflorescences abundant, present November to March, depending on rains, generally solitary, sometimes paired or accompanied by short lateral shoot bearing small leaves and short inflorescences, simple up to 9 cm long, or compound up to 14 cm long, rachis spreading or erect, yellowish-





FIG. 9.

*D. stipulosa*. 1 Adult tuber with current season's shoot and remains of previous shoots; 2 bract from basal portion of aerial stem; 3 leaf-base and stipules; 4 leaf from lower part of main stem; Male Plant: 5 inflorescences, 6, 7 flowers in surface and sectional views; Female Plant: 8 inflorescences, 9, 10 flowers in surface and side views; 11 cluster of ripe capsules; 12 sectional view of capsule; 13 seed. Scale = 50 mm fig. 1, 4, 5, 8, 11—13; scale = 10 mm fig. 2, 3; scale = 5 mm fig. 6, 7, 9; scale = 3.3 mm fig. 10.

green; flowers numerous, spreading, solitary or paired; pedicels up to 6 mm long; bract about 1 mm long, acute, deltoid, bracteole near top of pedicel, lanceolate; buds globular; perianth yellowish-cream, rotate, up to 7 mm diam, segments free almost to base, patent, recurved, outer oblong, about 3 mm long, 1.5 mm broad, margins decurved, apex obtuse, inner segments slightly narrower, shorter, acuminate, acute; stamens 6, filaments white, about one-third length of segments, attached to base of segments, outer erect, inner incurved, anthers dorsifixed, introrse, pollen yellow; style rudimentary, conical, tripartite.

*Female Flowers.* Inflorescence solitary, pendant, partially hidden by subtending leaf, rachis green, up to 9 cm long; flowers up to 30, spreading or slightly up-turned; pedicels up to 4 mm long; bract and bracteole lanceolate, acuminate, 1—1.5 mm long, bracteole about two-third way up pedicel; buds cylindrical; perianth yellowish-green, rotate, about 6 mm diam, persistent; segments equal, joined only at base, 2—2½ mm long, less than 1 mm wide, oblong, with median vein, obtuse; stamens rudimentary, modular; style cylindrical, erect, about 1 mm long, style branches three, horizontal, slightly shorter than style, apices bilobed, decurved; ovary inferior, joined by a short pseudo-pedicel about 5 mm long to perianth, trilocular, 6—7 mm long, 2 mm diam, narrowing slightly towards top, sharply three-angled, glabrous.

*Fruit.* Rachis elongates but remains pendant as fruit ripens, pedicels elongate to about twice length bearing ripening capsules erect; ripe capsules oblong, 27 × 15 mm, obovate, 24 × 14 mm, or broadly obovate, 20 × 20 mm, light yellowish-brown with reddish-brown margins and diagonal flecks, ripe July–August.

*Seeds* one to two in each locus, elliptical, flattened, 7 mm long, 4 mm wide, wing distal, membranous, reddish-brown, rigid, up to 16 mm long, 6 mm wide.

*Habitat.* *D. sylvatica* occurs in a variety of habitats in the Eastern Cape at altitudes ranging from 25 to 4,000 ft but always associated with some form of tree vegetation. In the *locus classicus* at Kraggakama it occurs on sandy soils formed from Table Mountain sandstones and quartzites. At the lowest altitudes of its range it is found in fixed dunes under a canopy of coastal bush. In both these localities *Sideroxylon inerme* and *Schotia speciosa* are common. On steep slopes of Witteberg quartzite it is associated with low temperate forest containing *Podocarpus falcatus*, *Schotia latifolia*; on shales of Dwyka and Ecce series it occurs on southern slopes of dry localities supporting low succulent scrub and small trees of *Ptaeroxylon utile* and *Schotia afra*; further north at highest altitudes of its range it occurs as a marginal forest creeper on loamy soils formed from the rocks and shales of the Karoo System.



FIG. 10.

*D. sylvatica*. 1, 2 Basal part of perennating stem from tuber on farm "Waterfall" 29/8/65 showing regeneration from lateral buds; A—C lateral shoots of previous years. F new 3 ft shoot of current season's growth. Leaves: 3 Lectotype, Ecklon & Zeyher Kragga Kamma, subtending ♂ infl.; 4 Archibald 7548, Kragga Kamma, subtending ♀ infl.; 5, 6, Archibald 7534, Rangemore, lowest of main stem, subtending fruit cluster; 7—9 Archibald 7608, Zwartwater Poort, largest from terminal lateral, from base of juvenile plant; 10 Noel 1460, Pluto's Vale, from 3rd node above fruit cluster; 11—12 Archibald 7573, Port Alfred, subtending short & long infls.; 13 Archibald 3411b, Kamaehs, from lower part of main stem; 14, 15 Barber 484 Queenstown, from main stem & lateral; 16 Barber 223 Queenstown, subtending ♀ infl.; 17 Large tuber from dune-sand. Scale = 50 mm fig. 1—16; scale = 50 cm fig. 17.

The tubers of *D. sylvatica* are occasionally cooked and eaten by Bantu people.

*Distribution:* LECTOTYPE. Cape Province, Port Elizabeth Division (formerly part of Uitenhage Division), "Primitive forest of Krakamma below 500' " Ecklon and Zeyher s.n. Jan. (AM) quoted in Ecklon 3·1. and locality in Ecklon, S.Afr. Quart. Journ. (1830). Actually the earliest recorded specimens are Burchell 3390 (K), collected at Zwartwater Poort on 8th July, 1813 and erroneously determined by him as *D. elephantipes*, and Burchell 4519, "Kkakamma—near the farm house" (K) which was collected on 31st January, 1814. Other important specimens are Zeyher 892 (or Ecklon 892 (K) part of which came from Uitenhage and part from Albany, and Zeyher 4152 (N, AM, K) "Howison's Poort mts and ravines west of Grahamstown".

CAPE PROVINCE: Uniondale Division, nr Wagenboom, north side of Kromme R. Burchell 4855 (not seen); Prince Alfred Pass, Fourcade 3487 (FC in B), Archibald 7588 (AM, K). Knysna Division, East Bank, Keurbooms River, Fourcade 3244 (B), Robberg, Taylor 985 (NBGK); Humansdorp Division, Cambria, Compton 24085 (NBGK); Uitenhage Division, Kamaehs, Paterson 1032 (AM), Archibald 3411b (AM); Port Elizabeth Division, between Kragga Kama and Sea View, Archibald 7458 (AM, K), Port Elizabeth, I. L. Drège 307, (AM), I. L. Drège, Dec., 1908 (N/10799T.M.), Long 921 (AM, N), Paterson, 1033 (AM), van Stadens River Mouth, Pole Evans 4876 (N); Alexandria Division, Bushmans River Mouth, Pole Evans 26M (AM, N), Archibald 4351 (AM), 7350 c/d, 5861 (AM, K, N), Syferfontein, Archibald 7248 (AM); Albany Division, Pluto's Vale, Dyer 1720 (AM), Noel 1460 (AM, RU), Waterfall (part of Thornkloof) Archibald 7610—7617 (AM, N,K), Zwartwater Poort. Archibald 7608 (AM, K); Bathurst Division, Port Alfred, Galpin 363 (N), Tyson June, 1916 (N), Archibald, 7573, 7527/b (AM, K, N), Kowie River, L. L. Britten 5112 (AM), Mentone, L. L. Britten 6465 (AM), Salt Vlei, L. L. Britten 2099 (AM), Kasouga, L. L. Britten 2365 (AM, N), Rangemore Farm. Archibald 7526, 7527, 7528, 7531, 7534, 7541, 7542 (AM); Somerset East Division, Bassonskloof, Bayliss 2895 (AM); Fort Beaufort, Hogsback Pass, Archibald 7556 (AM), Braeside, Story 2216; Queenstown Division, Junction, Farm Station, Galpin 8188 (AM); Stutterheim Division, Rogers 11950.

*D. sylvatica* and its published varieties:

It is unfortunate that the only characters used in establishing new varieties of *D. sylvatica* were the size, form and texture of the lamina and the size of the capsules. It will be realised from the above description that size and form of lamina vary considerably between juvenile and adult plants, and according to position on a single plant. There is every gradation in size and shape between



the hastate leaves on the upper parts of adult plants and the broadly ovate leaves of seedlings as is shown in the accompanying diagrams (fig. 10, 11). Leaf texture and capsule size are characters which are affected by drought conditions which may cause glaucous leaves and small capsules. It is possible that the plants from Pluto's Vale, Hogsback and Queenstown might be considered as a distinctive form but there has been no opportunity for a close study of plants of different ages to confirm this. It might be suggested that difference in size and shape of tubers of dune plants and inland forest plants should be used to separate varieties, but development of juvenile plants is so similar that the author is of the opinion that physical conditions of the soil are important in leading to differences in size and shape of tubers, and that over a period of say 30 years a seedling from rocky quartzitic area would develop into a large, lobed, subterranean tuber if grown in dune sand under coastal bush.

Burkill recognised four varieties based chiefly on differences in size and shape of leaves, but did not state from what portion of the plant the leaves illustrated were taken.

*Type localities for published varieties of D. sylvatica.*

- v. multiflora* (Marloth) Burkill = *D. marlothii*, R. Knuth = *Testudinaria multiflora* Marloth. Transvaal: Zoutpansberg, near Santa, coll. Dyke as Marloth 5097 (AM).  
*v. rehmanni* (Baker) Burkill = *D. rehmanni* Baker. Transvaal: Zoutpansberg, Houtbosch, Rehmann 7583.  
*v. paniculata* (Dümmer) Burkill — *D. paniculata* Dümmer. Kew Gardens, Locality unknown. (ref. also *T. montana* f. *paniculata* O. Kuntze. Natal: Durban.  
*v. brevipes* (Burt Davy) Burkill = *T. brevipes* Burt Davy. Transvaal: Potgietersrus, Leendertz 1510.

*Dioscorea elephantipes* (L'Heriter) Engler in Engler and Drude, Vegetat. d. Erde, 9.2, 267 (1908); Pflanzenwelt Afr. 2, 362 (1908); *Tamus elephantipes* L'Heriter, Sert. Angl. 29 (1788); *Testudinaria montana* Burchell, Travels Int. S. Afr. 2, 148 (1824); *Testudinaria elephantipes* Lindley in Bot. Reg. pl. 921 (1825). For further references see Burkill, Journ. S. Afr. Bot. 18, 186 (1952). Fig. 12.

*Plants* dioecious, leafy shoots dying back annually and being renewed from the crown.

*Tuber* perennial, epigeal; in seedling pear-shaped, of hypocotylar origin (Sparshott, 1935); in adult plants shaped like a beehive, base subterranean (about one-quarter of the whole), up to 60 cm diam, under-surface concave, with circular ridges, not reticulate, periphery irregularly undulating, not conspicuously lobed, with numerous, sparsely branched, wiry roots up to 5 mm

thick; upper three-quarters of tuber exposed above ground, total height up to 60 cm (a specimen recorded by Sir William Hooker in Guide to Glasgow Bot. Gard. was 90 cm diam, 210 cm high and weighed about 700 lbs), surface greyish-brown, hard, with numerous 4—7-sided tortoise-like plates of thick cork, plates increasing in number by splitting or *ab initio* from crown, increasing in size by peripheral growth, showing definite growth lines from central umbo, up to 8 cm across, up to 3 cm thick at centre; crown of one or more growing points at top of tuber, somewhat immersed marked by stiff, brown, erect, deltoid, bracts up to 10 mm long, 15 mm broad at base; inner flesh hard, yellowish-white, opaque, brittle. Formerly eaten by Bantu people.

*Stems* solitary in young plants, 4—7 in older plants from several growing points situated at the top of the tuber, growth dependent on rain, shoots generally appearing October–November, persisting for 10—14 months, if first shoot delayed by drought or injury growth renewed as late as February; main stem erect, rigid, becoming flexuous above, sinistorse, twining on remains of previous season's shoots or surrounding shrubs, up to 90 cm long, up to 15 mm diam at base, tapering rapidly, glabrous, dark liver-brown, much branched; lateral branches spreading more or less at *right angles*, forming rigid spines in dry weather when flexuous tips are deciduous or in second year after death of shoot.

*Leaves* exstipulate, alternate, sometimes opposite, bifacial, glabrous, deciduous in dry weather or at end of season; lower pulvinus variable, in leaves of ultimate branches about 1 mm long, 1 mm or less at base narrowing abruptly to width of petiole, in leaves subtending branches up to 5 mm long, base 5 mm wide, 2 mm thick, persistent, hard and woody when leaf falls; upper pulvinus less than 1 mm long, slightly thicker than petiole; petiole about 5 mm long, less than 1 mm diam, glabrous, pale yellowish-green; lamina generally folded upward somewhat about mid-vein, sides closing together in heat or drought, rarely fully expanded, 5—7-veined, size and shape variable, very broadly ovate acute, up to  $20 \times 18$  mm, very broadly ovate obtuse, up to  $26 \times 32$  mm or ovate depressed emarginate,  $23 \times 37$  mm, base rounded or slightly cordate with acute or generally obtuse sinus, pale yellowish-green, somewhat shiny when young, *glaucous* when old, lower surface with slightly protruding yellow veins, apex mucronate, mucro up to 2 mm long, deltoid, greenish-yellow to brown.

*Male Flowers.* Inflorescences present November–February, solitary or sometimes paired, simple or compound, rachis glabrous, yellowish-green, up to 8 cm long, 3 mm diam at base, tapering, rigid, patent or erect, forming a spine when flowers have fallen; flowers numerous, single or paired, erect or spreading; pedicels up to 5 mm long; bract and bracteole, 1—2 mm long, lanceolate, acuminate, yellowish-green; buds pyriform, erect or spreading; perianth mustard



coloured, funnel-shaped, 6—7 mm diam; segments joined in lower third to form a narrow tube, upper parts spreading, later reflexed, 2.5—3 mm long, 1 mm broad at base, outer spatulate, inner oblong obtuse, apices slightly inflexed; stamens six, inserted at lip of perianth tube, about two-thirds length of segments, erect slightly incurved above, cream, anthers basifixed, about one-third length of filaments, pollen yellow; style rudimentary, cylindrical, up to 13 mm long, apex irregularly tripartite.

*Female Flowers.* Inflorescences solitary, simple, pendant or spreading, up to 8 cm long, about 3 mm at base, tapering, rigid, becoming spine-like later, with up to 15 flowers; pedicels up to 2.5 mm long; bract and bracteole ovate-lanceolate, bract up to 1 mm long, bracteole shorter, distant at base of ovary, yellowish-green; buds somewhat cylindrical, generally erect by twisting of pedicels; perianth funnel-shaped, up to 6 mm diam, mustard-coloured, joined to ovary by a pseudo-pedicel about 1 mm long, 0.5 mm diam, segments equal, joined at base for about one-fifth of length, about 3 mm long, about 1 mm broad, oblong, upper part spreading, apex obtuse, incurved, upper surface glabrous with concave median line, under-surface with minute tubercles which also occur on outside of perianth tube; stamens rudimentary, white, about 0.5 mm long, anthers nodular; style lower part erect, cylindrical, up to 2 mm long, upper part three-branched, branches at right angles to main axis, about 0.5 mm long upper surface channeled, apex deflexed, bi-lobed, acute; ovary inferior, about 7 mm long, 1.5 mm diam, trilocular, three-angled, longitudinally ribbed, yellowish-green, with very fine tubercles visible with  $\times 20$  magnification.

*Fruit.* Pedicels elongating to about 7 mm, bearing capsule erect, capsule dry, three winged, up to 2 cm long, 1.8 cm broad at top, narrowing at base, flattened capsule very broadly obovate to nearly cylindrical, glabrous, light-brown with darker diagonal markings, dehiscing in upper third, ripe April–October.

*Seeds* one to two in each loculus, flat, circular, about 5 mm diam, wing distal, light brown, membranous, about 10 mm long, 7 mm broad.

*Habitat.* Growing at altitudes from 500 to 4,000 ft, on rocky slopes with eastern aspect in dry soils derived from quartzite of the Cape system or from shales of the Karoo system. Occurring in thorny and succulent karroid bush with *Carissa ferox*, *Gymnosporia* spp., *Rhus* spp., *Aloe* spp., *Crassula* spp. and variety of geophytes.

*Distribution.* The earliest records seem to be those of Thunberg and Masson who together reached the Sundays River (in the Uitenhage Division) on 16th December, 1773. According to Burkill there are two specimens of *D. elephantipes* in Thunberg's herbarium and the receipt of Masson's specimens at Kew was recorded by Aiton as 1774. L'Heritier saw the Kew specimens in 1788, probably





FIG. 12.

*D. elephantipes*. 1 Adult tuber; Male plant: 2 inflorescence, 3, 4 flower in surface and sectional views; Female plant: 5 inflorescences, 6 flower; 7 shoot bearing capsules; 8 developing seed; 9 ripe capsule; 10 ripe seed; 11 seedling; 12 juvenile plant. (11 and 12 after Sparshott, reproduced with permission from J. Linn. Soc., Bot., 49, 1935). Scale = 18 cm fig. 1; scale = 50 mm fig. 2, 5, 7—10; scale = 25 mm fig. 11, 12; scale = 6 mm fig. 6; scale = 5 mm fig. 3, 4.

also the specimen sent by David Nelson from the Cape in 1776. Burkill suggests that Nelson's specimen was obtained from Auge the Company's Gardener at Cape Town, who was well known to Thunberg and Masson and had accompanied Thunberg as guide on his first expedition to the eastern part of the country in 1772. James Niven who went to the Cape in 1798 and stayed until 1812 sent further tubers to Europe one of which, a female plant with a tuber one foot in diameter, flowered under the care of a horticulturist Joseph Knight. This plant was figured in the Botanic Magazine pl. 1347.

*D. elephantipes* is becoming increasingly rare in South Africa. Not only is it a horticultural curiosity but it is liable to destruction by angora goats which are now being bred in quantity in the Karoo veld. In the division of Albany in particular it is now very scarce. For example it was recorded over a period of five years from 1892 onwards on the farm Brakkloof by Mrs G. White, whose specimens of shoots are in the Albany Museum Herbarium. It was also known from several other farms in the district, but of recent years no specimens in these areas have been located in spite of enquiry and investigation.

CAPE PROVINCE: Clanwilliam Division, between Clanwilliam and Boschkloof, Meyer s.n., Aasvogelberg, Meyer s.n., Clanwilliam, Marloth 27151 (not seen); Graaff-Reinet Division, Mountains S.W. of Graaff-Reinet, Burchell 2913 (K), Mt. at Graaff-Reinet, Drège 8560c (K), Bowker 3 (K), hillside on farm nr. Rietvlei, Galpin 9971 (NH), Brandkraal, Kendrew coll. B. Hobson, Archibald 8014 (AM, N, K, B); Somerset East Division, Boschberg, MacOwan 1214 (K, HAMK); Pearston Division, valley 3 m west of Vogelriver, P. O. Acocks 12012 (N); Willowmore Division, mt. west of Miller Station coll. Andreae, Marloth 1002 (N); Albany Division, Brakkloof Farm, Mrs. G. White 484 Feb. 1892 (AM), Mrs. G. White s.n. May 1896 (AM), no name or no. Feb. 1908 (AM); Uitenhage Division, Ecklon 788 (K), Zwartkops Hills, Sundays River, Zeyher 583 (K, HMAK), Hoffman's Kloof between Enon and Zuurberg, Drège 8561 (K), Sundays River, Ecklon and Zeyher 34·3 (AM), between Karoo Bush on Sundays River, Ecklon and Zeyher (N ex Berlin Herb. 1936), ex Addo cult. Karoo Gardens, Whitehills, Compton 29096 (N), s.n. 3/41, 6/42, 2/43 (Comp. Herb. NBG); Humansdorp Division, Gamtoos River, Keeling 11732 (N), Patensie, Basson s.n. (in cult. RU). Without locality coll. I. H. Bowker, photo. only 21542 Herb. Mus. Afr. Kirstenbosch.

*Dioscorea hemicypta*, Burkill Journ. Lin. Soc. (Bot.) 53, 377 (1949); Journ. S. A. Bot. 18, 189 (1952); *Testudinaria glauca* Marloth in Herb. Fig. 13.

Plants dioecious, leafy shoots dying back annually and being renewed from the crown.

Tuber perennial, partially epigeal, presumably of hypocotylar origin (cf. *D. elephantipes*); seedlings not seen; in adult plants base subterranean (one-

third to a half of the whole), up to 60 cm across, concave, periphery irregular deeply lobed, outer surface corky, finely and irregularly reticulate, with numerous sparsely branched roots; upper part exposed above ground, total height up to about 45 cm, surface greyish-brown, with numerous tortoise-like plates, irregularly 4—6-sided, up to 3 cm across, up to 2 cm thick, increasing by formation from growing point or by splitting of old plate, with irregular lines of peripheral growth from central umbo, corky, hard; inner flesh hard, brittle, off-white; crown of several growing points at top of tuber, somewhat immersed or slightly conical, natural growth or injury may cause separation of crown into two or more parts, growing points marked by a few persistent, deltoid bracts. Tubers injured by predators or by tramping of grazing animals.

*Stems* solitary or several, growth dependent on rains, generally starting in December or early January, sometimes as late as March, shoots remain green for 8—12 months, later drying and forming a mass of rigid branches assisting support of new season's growth, when protected by surrounding bush lax, climbing freely, sinistorse, reaching a height of 2 metres, otherwise in exposed situations with short, erect, rigid stem about 30 cm long, up to 15 mm diam at base, dark olive-green, glabrous, tapering, freely branched; lateral branches more or less at *right angles*, yellowish-green, glaucous, forming rigid spines after leaf fall.

*Leaves* exstipulate, alternate, bifacial, glabrous, deciduous; lower pulvinus forming well developed, persistent leaf base on main stem and first laterals, otherwise lower and upper pulvinus inconspicuous, scarcely distinguished by thickness from petiole; petiole 2—6 mm long, about 0.5 mm thick, glabrous, spreading or erect; lamina with sides folding upwards about mid-vein, closing together in drought, 5—7-veined, broadly ovate obtuse, up to  $32 \times 26$  mm, or very broadly ovate emarginate, up to  $38 \times 38$  mm, base slightly cordate with obtuse sinus, pale yellowish-green, conspicuously glaucous in older foliage, with yellowish accretions showing on herbarium specimens, veins slightly more prominent on lower surface, apex mucronate, mucro deltoid, up to 2 mm long.

*Male Flowers.* Inflorescences present in January but dependent on rains, solitary, simple or compound, rachis erect, pale yellowish-green, glaucous, up to 13 cm long; flowers numerous, erect or spreading; pedicels up to 5 mm long; bract and bracteole 1 mm or less, deltoid, finely acuminate, separated from each other by length of pedicel; buds turbinate, pale glaucous-green above, dark olive- or brownish-green below; perianth funnel-shaped, shallow, 6—7 mm diam; segments joined at base for less than a quarter of length, mustard-green, equal, 3 mm long, about 1 mm wide, oblong, obtuse, decurved, three inner with incurved apex; stamens six, filaments joined to lip of perianth, about half length of segments, incurved, anthers basifixed, introrse, about 0.5 mm

long, pollen yellow; style rudimentary, conical, tri-partite, about 0·5 mm long,

*Female Flowers.* Inflorescences solitary, simple or sparingly branched, generally horizontal, angular, up to 12 cm long, later becoming hard and thorny; flowers up to 30 in number, erect; pedicels up to 5 mm long, about 1 mm thick, brownish-green, bract and bracteole about 1 mm long, deltoid, acute, the upper near base of ovary; buds oval; perianth rotate, mustard-coloured, about 6 mm diam, joined to ovary by a pseudopedicel about 0·5 mm long, 1 mm diam; segments about 3 mm long, 1 mm broad, joined in lower sixth to form a shallow funnel, upper parts spreading, outer elliptical, inner oblong with incurved apex, obtuse; stamens six rudimentary, filaments less than 0·5 mm long, joined to lip of perianth, erect, anthers nodular; style cylindrical, erect, about 1 mm long, 0·5 mm thick, style branches three, at right angles to style, less than 1 mm long, flattened vertically, apex bi-lobed, not deflexed, obtuse, with papillate margins; ovary inferior, 6—7 mm long, about 2 mm diam, olive-green, trilocular, sharply three-angled, glabrous.

*Fruit.* Erect, capsule dry, three-winged, up to 22 mm long, 16 mm broad, very broadly obovate, narrowing at base, glabrous, light creamish-brown with glaucous surface, dehiscing in upper third, ripe October–November.

*Seeds.* One to two in each loculus, flat, circular, about 5 mm diam, wing distal, light-brown, membranous, about 10 mm long, 7 mm broad.

*Habitat.* Growing on lower southern and south-eastern slopes of deep dry valleys, at altitudes of 1,000—2,500 ft, on loose scree slopes formed of decomposing shale and quartzitic rocks. Associated with *Portulaccaria afra*, *Rhus spp.*, *Gymnosporia spp.*, *Aloe mitriformis* and *Crassula spp.* and always in shelter of rocks or, more commonly, bushes.

*Distribution.* CAPE PROVINCE: Van Rhynsdorp Division, in mountains Langerberg, Marloth (K); Ladismith Division, nr. Ladismith, Marloth 3990 (K), Huis River Pass, Lewis 4018 (NBGK). Compton 4667, 8577, 7734 (NBGK). Thorns 21/2/39 (NBGK), Bond 24/3/40 (NBGK), Heginbotham 213 (NBGK), Wilson photo 117, 123, 100 (N), Marloth 12132 (N), Archibald 7589, 7590, 8010 (AM, K, N, B); Prince Albert Division, Prince Albert, Marloth 12731, Krige (B 12967); Oudtshoorn Division, Cango Caves, Marloth 12738, Watkins s.n., Compton 10746 (NBGK), Archer 413 (NBGK), Wilson photo. 93, 95 (N), Marloth 12132 (N), nr. Kamanassie Dam, Lewis 4551 (HMAK), Schoeman's Poort, L. Britten 1629 (AM), Bankhooghte, van Breda Nov. 57 (N).

#### ACKNOWLEDGEMENTS

An appeal for material of and information about some imperfectly known species of *Dioscorea* circulated by Mr E. Milne-Readhead of the Royal Botanic





FIG. 13.

*D. hemicrypta*. 1 Young adult tuber; Male plant: 2 inflorescences, 3, 4 flowers in side and sectional views; Female plant: 5 inflorescences, 6, 7 flower in surface and side views; 8 shoot bearing capsules; 9 capsule sectional view; 10 seed. Scale = 15 cm fig. 1; scale = 50 mm fig. 2, 5, 8, 9, 10; scale = 6 mm fig. 7; scale = 5 mm fig. 3, 4, 6.

Gardens, Kew, caused me to look more closely at the "local" species of *Dioscorea* and has resulted in the foregoing thoughts, descriptions and illustrations. I am most grateful to Mr Milne-Readhead for suggesting that my observations should be published independently and also for his co-operation in supplying information. I also wish to express my gratitude to the Director, Royal Botanic Gardens, Kew, for permission to dissect type material and to publish drawings thereof, and to the Council of the Linnean Society of London for permission to reproduce from the Society's Journal.

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#### ABBREVIATIONS USED FOR HERBARIA

AM—Albany Museum Herbarium, Grahamstown.

B—Bolus Herbarium, University of Cape Town.

HAMK—Herbarium of South African Museum, Kirstenbosch.

K—Royal Botanic Gardens, Kew.

NBGK—Herbarium of National Botanic Gardens, Kirstenbosch.

N—National Herbarium, Pretoria.

RU—Botany Department Herbarium, Rhodes University.

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# A. V. DUTHIE EN HAAR BYDRAE TOT DIE PLANTKUNDE\*

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## ABSTRACT

Augusta Vera Duthie (18th July, 1881 to 8th August, 1963) was the founder of the Department of Botany in the University of Stellenbosch. She received her botanical training in the Huguenot College, Wellington (South Africa), under the guidance of Dr. Bertha Stoneman and started as lecturer in Stellenbosch in April 1902. She was, presumably, the first South African trained botanist to be appointed as University lecturer in the country. She was Head of the Department until February 1921 and retired as Senior Lecturer in December 1939. She started lecturing in Stellenbosch under very difficult conditions but managed to lay sound foundations for botanical teaching and research. Her publications on the flora and vegetation of Stellenbosch are valuable contributions to Botany.

Wanneer 'n mens die geskiedenis bestudeer, word jy getref deur die besondere bydraes en rigtinggewende invloed van bepaalde persone wat jou bewondering en eerbied afdwing.

In die geskiedenis van die Plantkunde-departement van die Universiteit van Stellenbosch was dr. A. V. Duthie so 'n persoon. Sy was as die eerste dosent in Plantkunde aan die eertydse Victoria-Kollege die stigter van die Departement Plantkunde. Sy is, sover aan my bekend, die eerste plantkundige wat, na opleiding in Suid-Afrika, as dosent aan 'n Suid-Afrikaanse Universitêre inrigting aangestel is.

Dr. Duthie is al 'n paar jaar terug oorlede, maar daar is nog geen bespreking oor haar bydrae tot die Plantkunde in 'n wetenskaplike tydskrif gepubliseer nie. Met die hulp van dr. M. P. de Vos wil skrywer graag hierdie leemte in hierdie Eeufeesjaar van die Universiteit aanvul. Kort beriggies oor haar het wel verskyn, o.a. in *Eikestadnuus* op 16 Augustus 1963 en in *Matieland* en in die *Nuusbrief van die Suid-Afrikaanse Akademie* in Desember 1963.

Volgens die *Calendar of Victoria College and Boys' High School, Stellenbosch*, 1903 (bl. 33) het die Raad van die Victoria-Kollege vroeg in 1902 besluit om

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'n dosent in Plantkunde aan te stel. Die Victoria-Kollege het onder die Universiteit van die Kaap die Goeie Hoop geressorteer en die Universiteit het enkele jare tevore besluit om eksamens in Plantkunde vir graaddoeleindes af te neem. Die Hugenote Kollege, Wellington wat die eerste inrigting was om Plantkunde as vak vir die graad B.A. aan te bied (Phillips, 1930), het teen 1902 al gegradueerde studente met Plantkunde as hoofvak gelewer. Ongetwyfeld het professor Rudolf Marloth ook direk of indirek bygedra tot die Raad se belangrike besluit. Professor Marloth was 'n invloedryke plantkundige en het verskeie jare tevore al begin om Plantkunde in die Landbouskool te Stellenbosch aan te bied. Hy was ook een van die Universiteit van die Kaap die Goeie Hoop se eksaminatore in Plantkunde.

Die eerste dosent wat die Raad aangestel het, was die twintigjarige A. V. Duthie wat so pas die graad B.A. aan die Hugenote Kollege verwerf het. Die Raad moes goeie verslae oor die jonge Duthie van haar dosent, dr. Bertha Stoneman, en ander wat haar geken het, ontvang het om hierdie gewigtige besluit te neem.

#### LEWENSLOOP

Die vader van A. V. Duthie was luitenant Archibald Henry Duthie van Belvidere, Knysna. In 1868 is hy in Engeland met Augusta Vera Roberts getroud (Hart, A. en R., 1934). Hulle het drie seuns en twee dogters gehad. Augusta Vera is op 18 Julie 1881 op Belvidere gebore.

Die jonge Augusta het in Belvidere op die mooi ou familieplaas in die huis langs die Knysnameer opgegroeï. In 1899 gaan sy na die Hugenote Kollege in Wellington, studeer daar Plantkunde, Fisika en Matesis (Duthie, 1940) en verwerf in 1901 die graad B.A. van die Universiteit van die Kaap die Goeie Hoop. Die volgende jaar, op 1 April, aanvaar sy die betrekking as dosent in Plantkunde aan die Victoria-Kollege. Sy studeer as privaatstudent en na sy Deel I en Deel II van die graad M.A., onderskeidelik in 1909 en 1910, geslaag het, word die graad M.A. in Plantkunde in Desember 1910 deur die Universiteit van die Kaap die Goeie Hoop aan haar toegeken (Registrateur Univ. S. Afr., brief 25/4/1966). In 1912 was sy met verlof en bring die jaar in Cambridge deur. In 1920 gaan sy weer na die buiteland maar hierdie keer na Australië. Later bied sy van haar navorsingsresultate aan as 'n doktorstesis en in 1929 ken die Universiteit van Suid-Afrika aan haar die graad D.Sc. toe op grond van die proefskrif *Vegetation and Flora of the Stellenbosch Flats*. Op 31 Desember 1939 tree sy as senior lektrese uit die diens van die Plantkunde-departement maar, omdat sy nog verlof tot haar beskikking het, bly sy op die diensstaat van die Universiteit tot 31 Augustus 1940. Die res van haar lewe bring sy op Belvidere deur waar sy op 8 Augustus 1963 oorlede is en waar sy in die familiekerkhof langs die historiese Normandiese kerkie begrawe is.



DRIE PERIODES

Die werk van dr. Duthie op Stellenbosch kan in drie periodes ingedeel word t.w. 1902–1912, 1913–1920 en 1921–1939.

1902–1912.

Toe mej. Duthie in April 1902 hier kom, het 'n klas vir haar gewag want studente het by die begin van die jaar ingeskrywe en 'n mej. Walker het hul besig gehou tot mej. Duthie opdaag. Die Departement het een vertrek in die



PLATE I.  
A. V. Duthie (1881-1963)

noordelike vleuel van die ou Hoofgebou op Kollege-Plein tot sy beskikking gehad, maar verder niks nie—geen laboratoria, geen apparaat, geen mikroskope, geen versamelings, geen boeke, geen toelaag vir apparaat of boeke, geen kweekhuis of tuin en geen laboratorium- of tegniese assistente nie.

In die Stellenbossche Oudstudent van April 1940 vertel dr. Duthie iets van die moeilike beginjare van die departement. Sy het nie kans gesien om met die R100 per jaar wat die Raad haar aangebied het, die betrekking hier te aanvaar nie. Die owerhede het egter met Bloemhof gereël dat sy daar vry kon loseer. Vir hierdie „vry” verblyf en losies moes sy egter in Bloemhof toesig hou en daar sekere klasse in Plantkunde, Engels, Suid-Afrikaanse Geskiedenis, Godsdiens en Spraakkuns waarneem! Gelukkig is haar salaris later opgeskuif na R300 per jaar en kon sy die werk in Bloemhof laat vaar.

Ten die einde van 1902 rapporteer die Senaat van die Victoria-Kollege dat „the Senate considers that the College is to be congratulated on securing the services of so able and enthusiastic a teacher as Miss A. V. Duthie, B.A.” Terselfdertyd rapporteer die Raad dat „arrangements made during the past year for the teaching of Botany have proved satisfactory; but it is felt that fuller provision should be made in this direction, and the matter has been taken in hand by the Council”.

Klein toelaes vir die biblioteek en benodigdhede is deur die Raad aan die departement toegeken. Die biblioteektoelaes was egter so klein dat ’n goeie plantkundige tydskrif nie daaruit bekostig kon word nie. Die benodigdhedetoelaag was egter sodanig dat ’n paar mikroskope aangekoop kon word.

’n Aangeleentheid wat die jong mej. Duthie onmiddellik aandag aan gegee het, was die opbou van ’n herbarium. ’n Aansporing in hierdie verband was ’n prys van R10 wat die Onderwysdepartement uitloof het vir die inrigting wat die beste versameling van ’n paar honderd gemonteerde plante, met name, voorlê. Vir drie agtereenvolgende jare het die jong Plantkunde-departement van die Victoria-Kollege die prys gewen. Die eksemplare het die kern van die herbarium gevorm en met die verowerde pryse kon boeke aangekoop word. In die kalender van 1903 word al melding gemaak van die herbarium en in die kalender van 1904 kom die volgende voor: „The equipment at present consists of ten compound microscopes, a microtome and five hundred specimens, which, it is hoped, will form the nucleus of an extensive and representative herbarium of the flora of the Cape”.

Ten 1908 kry mej. Duthie deeltydse hulp in die persoon van mnr. J. W. Maxfield wat ook in die Dierkunde-departement behulpsaam was. Op 1 Januarie 1912 kom ’n tweede lektoraat tot stand en S. J. Garside word in die pos aangestel. Die periode 1902–1912 loop ten einde met mej. Duthie se terugkeer van Cambridge.

1913–1920.

Met 1913 begin bepaald 'n nuwe fase in die lewe en werk van mej. Duthie en in die geskiedenis van die Plantkunde-departement. Mej. Duthie het kort vantevore die graad M.A. behaal, is pas terug van studie oorsee en beskik nou oor die hulp van 'n voltydse en goed opgeleide lektor. Hierdie lektor, Sidney Garside, het die graad M.Sc. in Plantkunde in Manchester behaal en word, volgens Bolus en Jessop (1962), o.m. verantwoordelik gestel vir die doseer van plantfisiologie. Die periode 1913–1920 is 'n periode van aktiewe uitbouing en opbouing van die departement.

In hierdie periode kry die departement huisvesting in die Gebou vir Natuurwetenskappe wat in 1916 ingewy is. Die westelike helfte van die eerste verdieping wat deur die Plantkunde-departement betrek is, is deur mej. Duthie, met die hulp van mnr. Garside, beplan. Op aandrang van mej. Duthie is in die nuwe gebou voorsiening gemaak vir lokale vir 'n herbarium en 'n museum. Met die hulp van mnr. Garside bou sy die museum op tot een van die grootste plantkunde-museums in die land. In die nuwe gebou het die departement ook sy eerste eksperimentele laboratorium gekry.

In hierdie tyd beskik die departement ook oor 'n kweekhuis en 'n „tuin” op Kollege-Plein. Presies wanneer hierdie „tuin” tot stand gekom het en die kweekhuis opgerig is, is nie vasgestel nie. Die „tuin” het heel waarskynlik al voor 1913 tot stand gekom. In hierdie tyd beskik die departement ook al oor 'n laboratorium-assistent en in 1919 word aansoek om 'n tweede gedoen.

In hierdie periode word die Victoria-Kollege die Universiteit van Stellenbosch en die Plantkunde-departement 'n selfstandige departement wat nie meer gebonde is aan die leerplanne en die eksamens van die Universiteit van Kaap die Goeie Hoop nie.

In 1919 doen mej. Duthie om gesondheidsredes aansoek om 'n jaar verlof en bring die jaar 1920 in Australië deur. Sy het heelwat materiaal vir die museum en die herbarium uit Australië saamgebring.

1921–1939.

In Februarie 1921 tree mnr. Garside uit die diens van die Universiteit en word 'n professoraat in Plantkunde geskep. Teen die verwagtings van mej. Duthie se intieme vriende word sy nie in die professoraat aangestel nie. Die Raad se keuse het geval op dr. G. C. Nel wat op 1 Maart 1921 diens aanvaar het. Op 28 Februarie 1921 loop mej. Duthie se hoofskap van die departement dus ten einde en is sy voortaan 'n gewone dosent.

Met die koms van professor Nel word mej. Duthie se administratiewe drag verlig en haar doseerdrag meer gespesialiseerd. Professor Nel is voortaan verantwoordelik vir plantfisiologie en vir die anatomie en sistematiek van die

saadplante. Hy kry prof. P. A. van der Byl van die Stellenbosch-Elsenburg Landboukollege om Swamkunde in die departement te doseer. Mej. Duthie se hoof verantwoordelikheid is voortaan die morfologie van die outotrofe Cryptogamae en die tweedejaarsklas. Professor Nel neem die administrasie van die Algemene Herbarium waar, maar mej. Duthie bly in bevel van die Stellenboschse distriksherbarium wat sy opbou tot een van die grootste distriksherbaria in die land.

In hierdie tyd neem die aantal eerstejaars vinnig toe en kan die departement nie al die studente huisves nie. In 1929 kry die departemente Dierkunde en Plantkunde huisvesting vir hul eerstejaars in die Annexe. Amper dertig jaar later, in 1957, het die departement eers weer verdere akkommodasie bygekry en toe vir die eerste maal spesiale huisvesting vir nagraadse studente bekom.

#### LEERPLANNE EN KURSUSSE

Van die begin af het die Plantkunde-departement voorsiening gemaak vir die sogenaamde *Intermediate*-, *Pass*- en *Honours*-kursusse vir die graad B.A. Die *Intermediate* was die eerstejaarskursus en die *Pass* die tweede- en derdejaarskursus. Die honneurskursus kon ook in drie jaar voltooi word, maar vir B.A.-honneurs moes 'n diepergaande studie van sekere aspekte van die *Pass*-leerplan gemaak word.

Die leerplanne vir hierdie kursusse is tot 1917 voorgeskryf deur die Universiteit van die Kaap die Goeie Hoop. Die oudste leerplan vir die „Pass”-kursus wat in die *Calendar of Victoria College and Boys' High School, Stellenbosch* genoem word, behels die volgende: *Morphology. Anatomy and Histology. Physiology. Systematic Botany. Practical work*. Die oudste leerplan vir die honneurskursus bevat die volgende: *Advanced study of morphological, anatomical and histological botany. Outlines of the geographical distribution of plants. Historical development of our knowledge of the nutrition and assimilation of plants. Practical work*. Die *Pass*-leerplanne is algaande meer breedvoerig uiteengesit. Die honneursleerplan het min verander en selfs na die aanstelling van Garside word plantfisiologie nie aangebied nie.

Met die totstandkoming van die Universiteit in 1918 het die plantkunde-leerplanne aanvanklik nie verander nie. Dit is eers in 1921 met die koms van professor Nel en die herindeling van die werk, heeltemal herformuleer.

Mej. Duthie het ook later begin om vir spesiale kursusse voorsiening te maak. So bestaan daar in 1918 'n kursus vir 'n Diploma in Landbou. Later is daar ook 'n Natuurstudiekursus vir studente wat H.P.O.D. en Diploma in Huishoudkunde volg. Die Plantkunde-deel van hierdie Natuurstudiekursus, of Biologiekursus soos dit ook soms genoem is, is deur dr. Duthie tot haar aftrede waargeneem.



Die eerste voorgeskrewe boeke vir Plantkunde was Lowson se *Textbook of Botany*, Strasburger se *Textbook of Botany* en Edmond en Marloth se *Elementary Botany for South Africa*. Nuwe uitgawes van eersgenoemde twee boeke is vandag nog op die mark en Strasburger se boek word vandag nog deur baie beskou as die beste plantkundige handboek. Die boek van Edmond wat deur Rudolf Marloth vir Suid-Afrikaanse skole verwerk is, was vir 'n lang ruk die enigste boek waarin die plantkunde deur Suid-Afrikaanse voorbeelde geïllustreer is, en was, soos ook die herbarium wat sy dadelik begin opbou het, onontbeerlik om die Plantkunde 'n Suid-Afrikaanse kleur te gee.

Dr. Duthie het haar klasse deur medium Engels gegee. Aangesien haar studente vrae soms in Afrikaans beantwoord het, moes sy haar tog vergewis van die Afrikaanse plantkundige vakterme. In hierdie verband het professor J. H. Neethling vir haar en mnr. Garside gehelp.

#### NAVORSING

In die beginjare van die departement het mej. Duthie min geleentheid vir navorsing gehad. Haar eerste publikasie—oor die anatomie van *Gnetum africanum*—verskyn in 1912. Na 1921 het sy meer geleenthede vir navorsing en die meeste van haar publikasies verskyn ook na hierdie datum (kyk Bylae).

Mej. Duthie het haar toegespits op 'n studie van die plantsoorte en plantegroei in haar omgewing. Deur dit te doen het sy nie alleenlik die kennis van die plaaslike plantegroei en flora uitgebrei nie, maar sy het ook belangrike bydraes gemaak tot die internasionale Plantkunde. Haar publikasies het internasionale erkenning gekry en is en word dikwels in internasionale publikasies genoem.

Sy was 'n toegewyde en deeglike navorser. Ek verwys in hierdie verband net na haar studie van die plantegroei en flora van die vlakte om Stellenbosch.

Vir die studie van die flora van die Stellenboschvlakte het sy baie tyd op die vlakte deurgebring, en daar klein perseeltjies vir gereelde en deeglike waarneming afgesteek. Om die soorte nog deegliker te leer ken het sy grond van die vlakte na die departement gebring. Hier het sy die grond in bakke natgehou en elke plantjie deeglik bestudeer. So het sy talle plantsoorte „ontdek” wat sy voorheen nog nie op die vlakte waargeneem het nie. So het sy ook geleer om die soorte in hul verskillende ontwikkelingsstadia vanaf die kiemplantstadium in die veld uit te ken. Haar intensiewe studie van die vlakte het as gevolg gehad dat die Stellenboschvlakte plantkundig die bes bestudeerde area in die land, miskien die bes bestudeerde area in die wêreld, geword het.

Skrywer hiervan is baie beïndruk deur haar studie van en publikasies oor die Mycetoza (Myxomycetes, slymswamme)—'n groep organismes wat in die vegetatiewe fase „dierlik” en in die voortplantingsfase „plantaardig” is en

waarvan voorbeelde selde gesien word. Tog het mej. Duthie 'n uitstekende versameling hiervan opgebou—'n versameling waarvan 'n gedeelte vandag nog in die Plantkunde-museum gehuisves word.

In die genera wat dr. Duthie intensief bestudeer het, het sy verskeie nuwe plantsoorte ontdek en beskrywe. Op die Stellenboschvlakte is 13 van hierdie soorte t.w. vyf soorte van *Urginea*, drie soorte van *Isoetes*, twee soorte van *Eriospermum* en een elk van *Anthericum*, *Chlorophytum* en *Riccia*. Verskeie plantsoorte is na haar vernoem. Twee hiervan kom op die vlakte voor t.w. *Restio duthieae* en *Romulea duthieae* wat onderskeidelik deur N. S. Pillans en H. M. L. Bolus beskrywe is. Mevr. Bolus het ook *Psilocaulon duthieae*, *Ruschia duthieae*, *Stomatium duthieae* en *Impatiens duthieae* na haar vernoem.

#### STUDENTE

In die 38 jaar ('n rekord vir lengte van diens in die Plantkunde-departement) wat dr. Duthie aan die Plantkunde-departement verbonde was, het talle studente by haar klasse gevolg. Drie van haar oudstudente van voor 1918 wat later 'n belangrike rol in die plantkundige vakke op Stellenbosch gespeel het, is G. C. Nel, P. A. van der Byl en I. de V. Malherbe.

Die klasregisters van voor 1918 is nog nie opgespoor nie. Die oudste klasregister (dié van 1918) wat ter insae was, bevat die name van 42 eerstejaars (o.a. dié van J. J. Buhr), sewe tweedejaars en derdejaars wat dieselfde klasse gevolg het, een 01 (T1)-student en vyf studente wat die Diploma in Landbou gevolg het. Een van die tweedejaarstudente was mnr. G. C. Theron wat later ingeskrywe het vir die M.Sc. in Plantkunde. Die bekendste name kom voor in die Landboulys en ek noem die volledige lys: S. J. Botha, H. J. Malan, P. O. Sauer, C. T. van der Merwe, J. S. van der Spuy.

Later het die klasse heelwat groter geword en het daar jaarliks 'n groter getal studente by haar klasse gevolg. Die tweedejaarsklas wat haar hoof verantwoordelikheid was, was nooit groot nie. Haar grootste tweedejaarsklas, t.w. 15, het sy in 1939, in haar laaste diensjaar, gehad.

#### KOLLEGAS.

Omdat die personeel min gewissel het, het dr. Duthie in haar dienstyd min kollegas gehad. Op die vaste doserende personeel van die departement was daar net drie, t.w. mnr. S. Garside (1912–1920), prof. G. C. Nel (1921–1939) en dr. E. I. Markötter (1927–1939). As plaasvervangers was P. G. Jordaan (1935–1937) en M. P. de Vos (1937) vir kort tydjes saam met haar op die personeel.

In 1912 was 'n sekere mnr. W. C. Worsdell en in 1920 mej. Gertrude Torrance haar plaasvervangers. Mej. Torrance wat haar B.A. in Kaapstad behaal het, is later getroud met die bekende plantkundige van Cambridge, H. Hamshaw Thomas.

## DR. DUTHIE AS MENS

Om op twintigjarige leeftyd die taak aan te pak om 'n nuwe departement op te bou, vereis besondere hoedanighede van hart en verstand—van kennis, ondernemingsgees en deurstellingsvermoë. Mej. Duthie was 'n knap student wat haar werk nie net geken het nie, maar ook 'n groot liefde vir die natuur gehad het en 'n behae gevind het in kennis en begrip van plante. Haar werk was vir haar 'n plesier en sy het 'n toegewyde student gebly.

Dr. Duthie was 'n saggeaarde, fynbeskaafde en godsdienstige persoon wat altyd baie simpatiek in haar optrede was. Tog was sy ferm en beslis en regverdig. Sy was 'n beminlike persoon vir wie die studente hoë agting gehad het. Sy het selde, indien ooit, moeilikheid met dissipline in die klasse gehad. Dit word vertel dat toe prof. Nel by geleentheid vir haar versoek het om studente wat hulle nie in haar klasse gedra nie, by hom aan te meld, sy geantwoord het dat sy dit nie by hom sal aanmeld nie, maar dat sy onmiddellik sal bedank as sy dissiplinêre moeilikheid in haar klas sou ondervind (A. C. Wessels, mededeling).

Sy was 'n knap leermeester en as sy iets verduidelik het, het die studente dit verstaan. Daarby was sy 'n inspirerende dosent en talle studente sal kan getuig dat sy by hulle 'n liefde vir die natuur, die Biologie en die Plantkunde aangewakker het.

Dr. Duthie het 'n wye vriendekring onder plantkundiges in die land en in die buiteland gehad. Ek verwys net na 'n paar wat vir haar en vir die Plantkunde-departement van besondere betekenis was. Eerstens, dr. Bertha Stoneman, haar leermeester, wat haar nie net met 'n liefde vir Plantkunde geïnspireer het nie, maar by wie sy ook geleer het hoe om 'n departement te organiseer. Tweedens, mevr. H. M. L. Bolus, kuratrise van die Bolus Herbarium, 'n lewenslange vriendin, met wie dr. Duthie hartlik saamgewerk het en sonder wie se hulp en inspirasie dr. Duthie seker nooit die versamelings op Stellenbosch kon opgebou en die plante benaam het nie.

Dr. Duthie se broers is betreklik vroeg dood. Haar laaste oorblywende broer, William, is in 1933 oorlede en daarna het die verantwoordelikheid van die bestuur van die plaas op Belvidere op haar skouers gerus. Dit was ook 'n belangrike rede waarom sy betreklik vroeg uit die diens van die Universiteit getree het. Na haar aftrede kom haar plantkundige aktiwiteite tot stilstand.

Met haar aftrede het sy haar belangrike briofietversameling aan die Bolus-herbarium geskenk. Haar plantkundige literatuur het sy aan die Universiteit van Stellenbosch geskenk wat na haar dood ook haar versameling Knysna-plante ontvang het.

Ongeveer 2·6 hektaar (6·5 akker) van die Stellenboschvlakte is deur die Universiteit as 'n klein veldreservaat aan die Plantkunde-departement toegeken.

Ter verering van dr. Duthie vir wie die vlakke haar belangrikste „laboratorium” was, word dit die Duthiereservaat genoem.

#### BRONNE

Afgesien van die publikasies vermeld in die literatuurverwysings, is van die volgende bronne gebruik gemaak:—

1. Calendars of the University of the Cape of Good Hope.
2. Calendars of the Victoria College and Boys' High School, Stellenbosch.  
In elke *Calendar* of Jaarboek is o.m. jaarverslae van die Raad en Senaat.
3. Jaarboeke van die Universiteit van Stellenbosch.
4. Raadsnotules van die Universiteit van Stellenbosch.
5. Senaatsnotules van die Universiteit van Stellenbosch.
6. Klasregisters van die Departement Plantkunde van die Universiteit van Stellenbosch.

Die registers tot 1918 het vermoedelik verlore gegaan.

7. Korrespondensie tussen dr. Duthie en die Universiteit van Stellenbosch soos bewaar in die Universiteitslêers.

Die korrespondensie tot 1918 kon nie gevind word nie.

8. Briewe van dr. Duthie aan dr. H. M. L. Bolus.
9. Korrespondensie tussen dr. Duthie (na haar aftrede) en die Departement Plantkunde van die Universiteit van Stellenbosch.

Sover is nog weinig briewe wat dr. Duthie geskryf het terwyl sy op Stellenbosch was, opgespoor.

Verskeie persone wat dr. Duthie geken het, het op een of ander wyse inligting verskaf. Ek noem hier net die volgende:—

dr. H. M. L. Bolus, mevr. C. M. Bosman, mej. M. E. Cameron, G. C. Crafford, dr. M. P. de Vos, wyle mnr. S. J. Garside, dr. C. S. Grobbelaar, H. Herre, H. J. Malan, H. Meyer, mevr. J. T. Morrison, prof. J. H. Neethling, wyle prof. G. C. Nel, mevr. G. Hamshaw Thomas, A. C. Wessels.

#### FOTO'S

Foto's van dr. Duthie en van haar klasse is uiters skaars. Foto's wat van dr. Duthie en lede van haar klas op die Stellenboschvlakke geneem is, is verkry van dre. K. L. J. Blommaert en N. J. van der Merwe (beide lede van die Botaniese II-klas van 1937).

#### DANKBETUIGINGS

Graag wil ek die persone en instansies wat een of ander wyse behulpzaam was, bedank vir hul hulp. In besonder wil ek dr. M. P. de Vos bedank vir die



opstel van die lys van publikasies van dr. Duthie en vir mnre. R. B. van der Merwe en I. Kruger wat gehelp het om sommige van die bronne te deursoek.

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# DEFICIENCIES OF MAJOR NUTRIENT ELEMENTS IN *PROTEA CYNAROIDES* LINN., GROWN IN SAND CULTURE

## I. FOLIAR SYMPTOMS OF DEFICIENCIES

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### ABSTRACT

Foliar symptoms of deficiencies of the major nutrient elements (N, P, K, Ca, Mg, S, and Fe) of the giant protea, *Protea cynaroides*, were recorded in respect of plants grown in sand culture. In general these symptoms corresponded to those previously described for other species.

### INTRODUCTION

Relatively little is known concerning the nutrient requirements of indigenous South African plants. This is especially true of the Proteaceae (Schütte, 1960).

Because of the present interest in the breeding of this family of flowering plants, and their cultivation on a commercial scale, it has become important to know more about their physiology and in particular about their nutritional requirements. It was therefore decided to cultivate a member of the Proteaceae under greenhouse conditions, in order to study its reactions towards different nutrient elements. This study, which was undertaken with *P. cynaroides* Linn., appears to be the first attempt in this respect.

The present paper describes the symptoms resulting from deficiencies of the major nutrient elements. A subsequent paper will deal with the growth results and chemical composition of the plants.

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## MATERIAL AND METHODS

Seeds of *Protea cynaroides* Linn. (collected near Port Elizabeth) were germinated in flats of sand. After the expansion of two true leaves one plant was transferred to each of 24 clay pots, eight inches in diameter, with a drainage hole in the bottom. The pots were heavily coated with bitumastic paint and filled with acid-washed sand. The plants were grown in a greenhouse maintained between 8° and 30° C.

The nutrient solutions were made up with deionised water. Their composition is shown in Table 1.

TABLE I  
Composition of nutrient solutions used for the development of major nutrient element deficiencies in sand culture

				Ml. of stock solution per litre of nutrient							
				Complete (control)	-N	-P	-K	-Ca	-Mg	-S	-Fe
Ca (NO <sub>3</sub> ) <sub>2</sub> ·4H <sub>2</sub> O	..	..	..	5	—	5	5	—	5	5	5
KNO <sub>3</sub>	..	..	..	5	—	5	—	5	5	5	5
MgSO <sub>4</sub> ·7H <sub>2</sub> O	..	..	..	2	2	2	2	—	—	—	2
KH <sub>2</sub> PO <sub>4</sub>	..	..	..	1	1	—	—	1	1	1	1
NaNO <sub>3</sub>	..	..	..	—	—	—	5	10	—	—	—
MgCl <sub>2</sub>	..	..	..	—	—	—	—	—	—	2	—
Na <sub>2</sub> SO <sub>4</sub> (0·5 M)	..	..	..	—	—	—	—	—	4	—	—
NaH <sub>2</sub> PO <sub>4</sub> ·2H <sub>2</sub> O	..	..	..	—	—	—	1	—	—	—	—
CaCl <sub>2</sub> ·2H <sub>2</sub> O	..	..	..	—	5	—	—	—	—	—	—
KCl	..	..	..	—	—	1	—	—	—	—	—
K <sub>2</sub> SO <sub>4</sub> (0·5 M)	..	..	..	—	5	—	—	—	—	—	—
Fe-EDTA (0·5%)	..	..	..	3	3	3	3	3	3	3	—
Micronutrients*	..	..	..	2	2	2	2	2	2	2	2

\* Stock trace element solution: 2.86g H<sub>3</sub>BO<sub>3</sub>; 1.80g MnCl<sub>2</sub>·4H<sub>2</sub>O; 0.11g ZnCl<sub>2</sub>; 0.054g CuCl<sub>2</sub>·2H<sub>2</sub>O; and 0.02g H<sub>2</sub>MoO<sub>4</sub>·2H<sub>2</sub>O per litre.

Each container was drenched daily with 500 ml. of the appropriate nutrient solution. The effluent was collected in a second bottle, made up to 500 ml. with deionised water, and the process repeated the following day. Nutrient solutions were changed once per week. From time to time the sand was leached thoroughly with deionised water.

For the first four weeks a complete nutrient solution was applied at half strength and subsequently at full strength. One week later the different nutrient solutions listed in Table 1 were applied. Prior to application the pH of each solution was adjusted to 6.0 with N NaOH. As a result of this procedure all plants except the controls died. The experiment was thereupon repeated, with the difference that the complete nutrient solution was applied for 31 weeks before commencing the different treatments. After another ten weeks, all except the control plants had developed deficiency symptoms. These were carefully noted and the plants photographed before harvesting.



#### DEFICIENCY SYMPTOMS

*Nitrogen deficiency:* The oldest leaves showed the first clear symptoms. In the early stages they were pale, yellowish-green. These symptoms progressed upwards in the direction of the tips of shoots; more or less at the same time the tips of the old leaves showed severe signs of chlorosis. Brown areas appeared in the centre of the laminae of the oldest leaves. This phenomenon was accompanied by the development of necrotic areas, which spread from the leaf tips towards the petioles. Shortly afterwards the old leaves abscised.

Nitrogen deficiency had the most profound effect on the general growth of the plants. They remained stunted and some of the plants died.

*Phosphorus deficiency:* The symptoms produced in the absence of phosphorus were in many ways similar to those resulting from nitrogen deficiency. The first symptoms appeared in the oldest leaves. As in the case of nitrogen deficiency the leaf tips were chlorotic, while the rest of each leaf had a dull bluish-green colour. Purple tints first appeared as isolated areas on the petioles, from where they spread to the leaf margins. Subsequently the laminae of the leaves tended to curl upwards and forwards.

The leaves were generally small in comparison to those of the control plants, older leaves were shed prematurely.

*Potassium deficiency:* Deficiency symptoms appeared first on the older leaves. At first necrotic areas appeared at the tips of the leaves (tip burn), from where they spread along the margins towards the petioles. The lateral shoots showed severe symptoms of die-back. The leaves had a dull bluish-green colour, with light-yellow spots in interveinal areas. These spots gradually turned brown; similar spots developed on the petioles. Soon after the appearance of the brown areas the leaf laminae started curling upwards. The leaves abscised when approximately two-thirds of their laminae had become necrotic.

*Calcium deficiency:* The first of calcium deficiency appeared as a general spindliness of the stems, with the young leaves showing irregular forms. After some time necrotic areas developed along the margins of the older leaves. The necrosis progressed until all the leaves were dead, leaving only the growing points of the stems intact; these probably would have died later. When harvested, it was found that the stems and roots had a gelatinous consistency (Plate I).

*Magnesium deficiency:* Symptoms first appeared on the oldest leaves, the tips of which turned chlorotic. Subsequently the interveinal regions turned slightly chlorotic. The leaf tips died and the leaf margins curled upwards. Brown spots appeared on the petioles and some of the leaf veins turned purple. These symptoms generally did not progress any further, but in a few cases the brown and purple areas turned necrotic (Plate II).



PLATE I. *Protea cynaroides* in sand culture.  
Calcium deficiency:  
Old leaves dead; plant gelatinous when harvested.



PLATE II. *Protea cynaroides* in sand culture.  
Magnesium deficiency:  
Tips of older leaves chlorotic, necrosis developing; purple spots on petioles.

*Sulphur deficiency:* There were no well-defined symptoms, although the leaves became somewhat chlorotic. Chlorosis first appeared along the leaf margins and gradually spread towards the mid-ribs. Later a number of veins and leaf margins developed high red tints.

*Iron deficiency:* Chlorosis developed first in the young leaves, and spread downwards towards the older leaves. At first the chlorosis assumed a mottled pattern, while the veins were yellowish-green. As the symptoms progressed, the interveinal areas turned yellow and small necrotic areas developed (Plate III).



PLATE III. *Protea cynaroides* in sand culture.

*Iron deficiency:*

Severe chlorosis of leaves; most severe on younger growth. Foreground: A small *Protea eximia* plant showing the same symptoms as *P. cynaroides*.

#### CONCLUSIONS

The deficiency symptoms which developed in the absence of the different major nutrient elements are essentially similar to those which have been described for other plants (Wallace, 1961; Lockard and Asomaning, 1964; Nichols, 1964). Certain symptoms, e.g. chlorosis, were common to several deficiencies.

The symptoms of a deficiency of nitrogen, phosphorus, potassium, and magnesium all started at the basal leaves, and developed in an upward direction towards the tips of the shoots. In the case of calcium-deficient plants the young leaves first showed malformations, but the older leaves died first, with necrosis progressing towards the younger parts of the plants. Although one might recognise a plant as suffering from malnutrition, it might prove difficult to diagnose specific nutrient deficiencies of *Protea cynaroides* in the field.

A few plants of *Protea barbiger* and *Protea eximia* were grown under conditions similar to those of *P. cynaroides*, and developed deficiency symptoms which corresponded to those described in this report.

#### ACKNOWLEDGEMENTS

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## NOTES ON MESEMBRYANTHEMUM AND ALLIED GENERA

H. M. L. BOLUS

**Cheiridopsis albirosea** L. Bol. sp. nov. (*Grandes—Denticulatae*).—Planta 1 visa, senectissima, ad 7 cm. alta, ca. 12 cm. diam.; partes herbaceae molliter pubescentes, brunneo virides; folia supra lanceolata, acuta vel subobtusata, lateraliter visa fere semicircularia vel oblonga superneque leviter dilatata, truncata, obscure denticulata, 2—3 cm. longa, basi laminae ad 1 cm. lata; pedunculi teretes, 1—1·6 cm. longi, 1·5—2 mm. diam., basi bracteati, bracteis obscure denticulatis, semicircularibus vel late obovatis; receptaculum globose obconicum, 7 mm. longum, ad 8 mm. diam.; sepala 5, exteriora minutissime apiculata, e parum supra basim gradatim angustata, 7—9 mm. longa, basi 4—6 mm. lata, interiora ample marginata, apud apicem minute subulata, 7—8 mm. longa, basi 4—5 mm. lata; petala ca. 6-seriata, interiora pauca, exteriora e bene infra medium inferne leviter angustata, saepius acuta, inferne alba, superne pulchre rosea, 1·1—3 cm. longa, 0·5—1·25 mm. lata; stamina ca. 6-seriata, alba, ad 7 mm. longa, intima parum supra basim papillata; ovarium supra circa marginem planum, medio lobato, lobis obtusis, ca. ad 0·75 mm. elevatis; stigmata ca. 12, gracilia pallida, 6 mm. longa.

Cape Province: Namaqualand; *P. van Heerde*. Fl. hort. van Heerde Sept. 1966. Bolus Herbarium 27829.

**Cheiridopsis dilatata** L. Bol. sp. nov. (*Grandes—Denticulatae*).—Planta 1 visa, crebre ramosa, ad 7 cm. alta, ca. 11 cm. diam.; partes herbaceae molliter pubescentes; folia inferiora lanceolata acuminata, ad 5 cm. longa cum vagina 1·5 cm. longa, lateraliter visa superne gradatim dilatata, latissima parum supra medium, ad 1·5 cm. diam., deinde ad apicem subtruncatum, obscure denticulatum, ad 7 mm. diam., angustata, immatura conspicue denticulata, folia superiora non dilatata, ad 4·1 cm. longa ad 6 mm. lata diametroque: pedunculi ad 2·5 cm. longi, apice 3 mm. diam., basi bracteata, bracteis obscure denticulatis; receptaculum globose obconicum, 4 mm. longum, apice 7 mm. diam.; sepala 5, rubre apiculata, apiculo ad 1 mm. longo, fere lanceolata, superne leviter compressa, 1·2—1·3 cm. longa, basi 4—7 mm. lata; petala

ca. 5-seriata, inferne leviter angustata, obtusa, albida vel interdum pallide aureo suffusa, ad 2·6 cm. longa, ad 1·5 mm. lata; filamenta ca. 5-seriata, alba, ad 5 mm. longa, parum supra basim papillata, antheris pollineque pallide luteis; ovarium supra circa marginem planum, lobis levissime elevatis; stigmata 13, pallide viridia, ad 6 mm. longa.

Cape Province: Namaqualand; "on the bit of road running from the Poffadder Rd. to Concordia." *P. van Heerde*. Fl. hort. van Heerde Sept. 1966. Bolus Herbarium 27828.

***Drosanthemum pickhardii*** L. Bol. sp. nov. (*Aspericaulia*—*Speciosa*).—Rami plures culti visi, graciles, ad 15 cm. longi, ad 9 cm. diam., internodi saepius 1—2 cm. longis, ad 2 mm. diam., ramulis 2—5 cm. longis; partes herbaceae inconspicue papillatae; folia ascendunt, supra visa plana subacuta, lateraliter visa prope apicem leviter angustata, obtusa, dorso rotundo, viridia, 1—1·5 cm. longa, ad 2·5 mm. lata, ad 3 mm. diam.; flores ad 4·2 cm. diam.; pedunculi 1—3 cm. longi; receptaculum obconicum vel fere subpiriforme, saepius ad 7 mm. longum diametroque; sepala 5, crassa obtusa, exteriora 2—3 mm. longa, basi 4—5 mm. lata, interiora 4—5 mm. longa, basi 3 mm., vel complanata ad 5 mm., lata; petala ca. 5-seriata, seriebus interioribus 3 acutis vel acuminatis, exterioribus e prope medium inferne angustatis pallidisque, oculum formantibus, obtusa, aurea vel rubre aurantiaca, ad 2·1 cm. longa, ad 2 mm. lata; staminodia atra obtusa, ad 3 mm. longa; stamina ca. 4-seriata, albida, ad 3 mm. longa, intima prope basim obscure papillata; glandulae approximatae; ovarium supra planum, lobis stellate patentibus, glandulas attingentibus, compressis; stigmata 5, anguste subulata, minute parceque intus papillata, ad 2 mm. longa cum cauda ca. 0·5 mm.; capsula brunnea, infra obconica, obtuse 5-angulata, ad 8 mm. longa, 9 mm., expansa, 1·3 cm. diam., supra fere ad 2 mm. elevata, suturis valde compressis.

Cape Province: in dit. Robertson; Montagu, Oct. 1932, *R. Pickhard*. N.B.G. 2610/32. Fl. Oct. 1933.

Ad ***D. pulchrum*** L. Bol. valde affine sed differt sepalis exterioribus brevioribus; petalis non luteo vittatis, inferne pallidis et oculum formantibus; stigmatibus anguste subulatis, intus parcissime papillatis, cauda multo brevior.

Note.—The type of ***D. splendens*** L. Bol. was also collected by *R. Pickhard* (N.B.G. 2609/32) at Montagu and constitutes a third species having the same type of sepals.

***Drosanthemum hallii*** L. Bol. sp. nov. (*Aspericaulia*—*Speciosa*).—Rami plures feri visi, rigidi, fere erecti, ad 27 cm. longi, ad 5 mm. diam., internodiis 1—4·5 cm. longis; ramuli floriferi 1·5—4 cm. longi, 1 mm. diam.; folia saepe fere erecta, supra plana linearia acuta, dorso rotundo, lateraliter visa superne non angustata vel interdum prope apicem leviter recurva angustataque, papillis

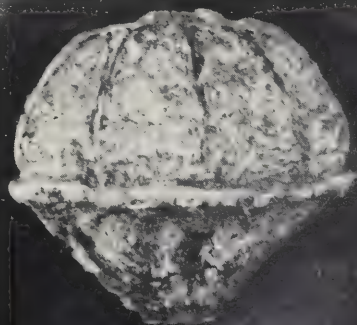
inconspicue nitentibus, viridia, 1—2·6 cm. longa, ad 2·5 mm. lata, 1·5—2·5 mm. diam., vagina subnulla; flores 3·5—4 cm. diam.; pedunculi minute nitentique papillati, 5—20 mm. longi; receptaculum globose obconicum, papillatum, 5 mm. longum, 6—7 mm. diam.; sepala exteriora e parum supra basim angustata, subacuta, 5—6 mm. longa, basi ad 4 mm. lata, interiora superne breviter subulata, subula patente, ad 5 mm. longa, basi 2·5—4 mm. lata; petala ca. 5-seriata, interiora paucissima, filamentosa, ad 8 mm. longa, exteriora e prope medium inferne angustata, acuta vel acuminata vel rarius obtusa, laete lutea, ad 1·8 cm. longa, 0·5—1·5 mm. lata; staminodia atra paucissima, ad 2 mm. longa; filamenta ca. 5-seriata, intima prope basim obscure papillata, cum antheris pollineque albis; glandulae sat inconspicuae, subdistantes; ovarii lobi compressi, sat distantes, ad 1 mm. elevati; stigmata 5, grosse papillata, ad 2 mm. longa cum cauda ad 0·75 mm. longa; capsula ad 9 mm. longa, 9 mm., expansa, 1·4 cm., diam., supra per 2 mm. elevata, suturis valde compressis, carinis inferne parallelis sed non contiguis, superne divergentibus, integris, brevissime aristatis.

Cape Province: in dit. Worcester; "on very stony slope 2 miles E. of Rawsonville, near Worcester," Oct. 1960, *H. Hall* 2119. N.B.G. 877/60.

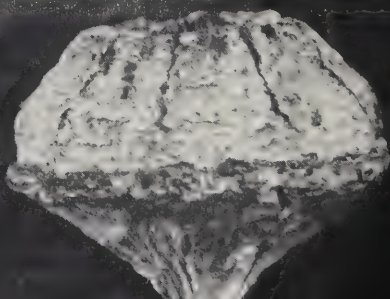
Note.—A more luxuriantly grown form of this species was collected on "hills S. of Brandvlei", near Worcester by F. J. Stayner and flowered in Oct. 1962. Karoo Garden 780/62.

***Leipoldtia compressa*** L. Bol. var. ***lekkersingensis*** L. Bol. var. nov.—Planta visa, 2·5 cm. longa, caule 3 mm. diam.; rami primarii ad 19 cm. longi, internodiis 1—3 cm. longis, cuticula brunnea vel rubre brunnea; ramuli ad 9 cm., ultimi floriferi (cum floribus 1—3-natis) 3—4 cm., longi, ad 6-foliati; folia ascendunt vel late patentia, supra visa oblonga obtusa, lateraliter visa obtusa vel apice rotundo, 1—1·8 cm. longa, 6 mm. lata, matura 4—9 mm. diam.; flores ad 4·2 cm. diam.; pedunculi sat robusti, 1·3—5 cm. longi, ad 1·25 mm. diam., saepissime infra medium bracteati, bracteis 5—10 mm. longis; receptaculum obconicum, 3 mm. longum, ad 7 mm. diam.; sepala 5, obtusa, 6—8 mm. longa, basi 2—4 mm. lata, interiora marginata; petala ca. 3-seriata, e parum supra medium inferne leviter angustata, obtusa, inferne alba, superne pallide rosea, ad 1·5 cm. longa, ad 1 mm., vel parum ultra, lata; staminodia ad stamina adpressa eaque leviter excedunt, albida; filamenta ca. 3-seriata, nivea vel pallidissime rosea, ad 9 mm. longa, intima parum supra basim papillata; ovarium minute tuberculatum, supra semiglobose ad 1·5 mm. elevatum, lobis obscuris; stigmata 10, gracilia, breviter caudata, 4 mm. longa; capsula senecta infra globose obconica, 5 mm. longa, 7 mm., expansa, 1·4 cm., diam., supra per 5 mm. elevata, apice 5 mm. diam., valvis expansis patentibus vel recurvis, apice vero erecto, carinis inferne parallelis, superne divergentibus, vix dimidium

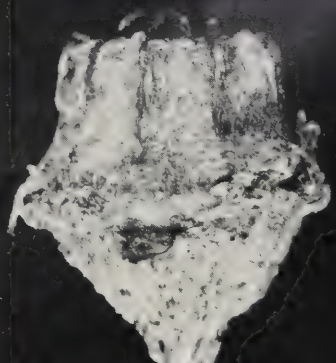
1.



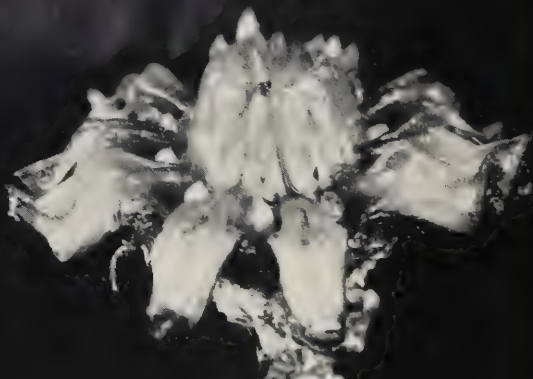
2.



3.



4.



5.



6.



## PLATE 1.

Capsules of three species of the genus *Leipoldtia*.



valvae attingentibus, alis apicem attingentibus, alis loculorum erectis, ad 1.75 mm. altis.

Cape Province: Namaqualand; "2 miles S.E. of Lekkersing," *R. C. Littlewood*. Karoo Garden 939/62. Fl. July 1964.

This species and especially its variety described above have the upper part of the capsule turret-like, the valves being upright, with their apex inflexed and giving a truncated top, a form not recorded in any other genus of the *Mesembrieae*. The cell-wings are also erect, the seeds being confined to the receptacle. This seemed to justify the creation of a new genus; but Dr. Ihlenfeldt, whom I consulted, has made a most interesting series of photographs, showing gradations from the more normal forms to the turret-form. A small selection of these is reproduced here.

We are greatly indebted to him for this service.

Note.—The type specimens of all new species described in this paper are in the Bolus Herbarium, University of Cape Town.

*(To be continued)*



## NOTES ON THE GENUS DELOSPERMA (MESEMBRIEAE)

M. LAVIS

**Delosperma monanthemum** Lavis sp. nov. (*Angustifolia*).—Rami 38 visi, quorum 33 florem singulum apud apicem ferunt, gracillimi pallidi, 7—18 cm. longi, internodiis 4—22 mm. longis, 0.75—1.75 mm. diam.; radix lignosa, ad 5 mm. diam.; partes herbaceae glabrae; folia ascendentia vel patentia, supra linearia, prope apicem leviter angustata vel abrupte acuta, plana vel leviter concava, lateraliter visa obtusa, dorso subrotundo, 1.3—2.4 cm. longa, 1.5—4 mm. lata, ad 3 mm. diam.; flores 2.4—3 cm. diam.; pedunculi saepius 2—3.8 cm. longi; receptaculum subclavatum, 3—4 mm. longum diametroque vel in floribus senioribus ad 5 mm. longum diametroque; sepala 5, exteriora 6—7 mm. longa, basi 2 mm. lata, interiora ad 4 mm. longa, basi 1.5 mm. lata; petala ca. 2-seriata, e parum supra medium inferne angustata, irregulariter emarginata vel 3-denticulata, roseo purpurea, ad 1.3 cm. longa, ad 1.5 mm. lata; staminodia diu erecta, demum apicem versus spiraliter recurva, rosea, stamina excedentia, ad 5 mm. longa; filamenta ca. 3-seriata, conferta, exteriora ciliate parce papillata, intima apud medium vel parum supra longe papillata, antheris pollineque luteis; glandulae obscure crenulatae humiles; ovarium circa marginem planum, lobis abrupte ad per 0.75 mm. elevatis, obtuse compressis; stigmata demum ad 5 mm. longa, anguste subulata, intus conspicue papillata, 5 mm. longa cum cauda 0.75 mm. longa.

Locality uncertain: Bolus Herbarium 27827. Fl. hort. L. Bolus, Jan.—Apr. 1942—1944.

Described from dried specimens and dissections and notes made by L. Bolus from living material.

**Delosperma wiumii** Lavis sp. nov. (*Angustifolia*).—Rami 3 visi, graciles glabri, copiose ramulosi, ad 8 cm. longi, internodiis 5—18 mm. longis, ca. ad 2 mm. diam.; ramuli floriferi ad 6 cm. longi, 0.5 mm. diam.; folia saepissime ascendentia, supra linearia, superne leviter angustata, obtusa vel subacuta, 1.4—3 cm. longa cum vagina ca. ad 1 mm. longa, 2—3 mm. lata diametroque; flores 1—3-nati; pedunculi gracillimi, 3—9 mm. longi; receptaculum obconicum, ad 2 mm. longum, 3 mm. diam.; sepala 5, 3—6 mm., vel 2—4 mm., vel 2—3

mm., longa, basi 1—1·5 mm. lata, omnia  $\pm$  marginata; petala ca. 3-seriata, laxa, inferne leviter angustata, apice fere rotundo, inferne pallida, superne pulchre rosea, 4—7 mm. longa, 0·5—1 mm. lata; staminodia petaloidea numerosa, stamina bene excedentia; filamenta 3—4-seriata, ad 2 mm. longa, interiora prope medium dense papillata, papillis praecipue longis; glandulae subapproximatae; ovarium supra circa marginem planum vel leviter concavum, deinde abrupte obtuseque leviter elevatum, lobis subapproximatis; stigmata anguste subulata, ca. 1·5 mm. longa cum cauda 0·5 mm. longa.

Orange Free State: "Langeberg, 12 miles East of Bethlehem, top of Asvoel's Krans, sandy soil between sandstone rocks, altitude ca 6,200 ft. plentiful," January 8, 1954. *E. J. F. Wium* 10. Fl. hort. L. Bolus Mart. 1955.

Described from dried specimens, dissections and notes made from living material by L. Bolus.

The following 4 species are described from dried material and drawings in colour made from living material by Miss B. O. Carter.

**Delosperma giffenii** Lavis sp. nov. (*Angustifolia*).—Planta l visa, rigida, 45 cm. alta, radice lignosa, 1·2 cm. diam., caule 7 mm. diam., laxissime ramosa; rami 16—27 cm. longi, internodiis 1·1—3 cm. longis, 1—2 mm. diam., pallidis vel subrubidis; folia ascendentia vel patentia vel recurva, supra plana linearia, longe acuminata, obscure carinata, sparse minuteque papillata, papillis setiferis, setis decurvis, duplo longioribus quam papillis, 2·2—4·3 cm. longa, parum supra basim 3—4 mm. lata, 2 mm. diam.; flores 1—3-nati, ad 2·4 cm. diam.; pedunculi a receptaculo bene distincti; receptaculum subglobosum, ca. 3 mm. longum diametroque; sepala 5, valde inaequilonga, exteriora longe acuminata, ad 1·5 cm. longa, basi 3 mm. lata, interiora acuminata 3—5 mm. longa, 1·5—2 mm. lata; petala 4-seriata, intima acuta, exteriora irregulariter emarginata, roseo purpurea, ad 9 mm. longa, ad 1 mm. lata vel parum ultra; staminodia alba vel superne rosea, stamina leviter excedentia; filamenta 4-seriata, seriebus 3 infra medium papillatis, pallidissime roseis, antheris pollineque luteis; glandulae approximatae, obscure crenulatae, humiles; ovarium circa marginem planum, lobis erectis, obtuse compressis, ad 0·75 mm. elevatis; stigmata anguste subulata, ad 1·5 mm. longa cum cauda ca. 0·75 mm. longa.

Cape Province: in dit. Albany; Fort Hare, Feb. 1935, *M. H. Giffen* 602. Fl. hort. L. Bolus Apr. et Junio 1935.

**Delosperma reynoldsii** Lavis sp. nov. (*Angustifolia*).—Plantae 2 visae, ferae glabrae sublignosae, caule apud basim ad 7 mm. diam., dense ramosae ramulosaeque, 15—17 cm. altae, ad 17·5 cm. diam.; rami primarii ad 15·5 cm. longi, internodiis ad 2 cm. longis, ad 5 mm. diam.; partes herbaceae conspicuissime papillatae, papillis rotundis, subglaucae, interdum roseo tinctae; folia ascendentia vel subfalcata, supra fere plana, prope apicem leviter angustata, obtusa, later-



ibus convexis, dorso rotundo, 2—4 cm. longa, ad 6 mm. lata diametroque; flores 1—3-nati, vel interdum fere 2-ternati, cymam 4 cm. longam, 2 cm. diam., formantes; pedunculi 3—8 mm. longi; receptaculum obconicum, 5 mm. longum, apice 6—7 mm. diam.; sepala 5, extima obtusa, 8—9 mm. longa, basi 5 mm. lata, interiora acuta, 6—7 mm. longa, basi 4—5 mm. lata; petala ca. 3-seriata, e prope medium inferne angustata, obtusa vel saepissime leviter irregulariterque emarginata, roseo purpurea, 2·1 cm. longa, ad 2 mm. lata; staminodia gracilia, prope apicem leviter recurva, acuminata, roseo purpurea, stamina excedentia; filamenta 8-seriata, seriebus 2 interioribus prope medium inconspicue papillatis, rosea ad 8 mm. longa, antheris pollineque pallidis; glandulae subapproximatae crenulatae; ovarii lobi stellate patentem, obtuse compressi, ad 1 mm. vel parum ultra elevati; stigmata 5, anguste subulata, 6 mm. longa cum cauda fere 2 mm. longa.

Orange Free State: near Ficksburg, "flat grass veld, rather sandy soil, forms patches, 2—3 feet across, quite showy." Fl. Sept. 1938. *G. W. Reynolds* 3030. Typus. "Also seen quite plentiful inside the Railway fence between Clocolan and Ficksburg, and also seen north of Ficksburg." "13 miles north of Ficksburg." Dec. 1934. *E. E. Galpin* N.B.G. 2556/34.

***Delosperma fredericii*** Lavis sp. nov. (*Cymosa*—*Frutescentia*).—Rami primarii 8 visi, 27 cm. longi, 30 cm. diam., basi ad 4 mm. diam., internodiis 5—18 mm. longis, ad 2·5 mm. diam., copiose ramosi ramulosique, floriferis ultimis gracilimissis, ad 9 cm. longis; folia saepius ascendentia, demum patentia, triquetra, supra visa acuta, lateraliter visa prope apicem angustata, apice interdum leviter recurvo vel subtruncato, leviter politaque, saepius 1—1·5 cm. longa, 2—3 mm. lata diametroque; cymae ternatae vel irregulariter 2-ternatae vel 3-ternatae, 4·5—13 cm. longae, 2—11 cm. diam.; pedunculi subintrusi gracilissimi, prope apicem dilatati, 6—13 mm. longi; receptaculum minute hispidum, obscure 5-lobatum, lobis rotundis, 1 mm. longum, 4 mm. diam.; sepala 5, acuta, exteriora 3—4 mm., vel rarius ad 5 mm., longa, basi ad 1·5 mm. lata, interiora 2—3 mm. longa, basi ad 1·25 mm. lata; petala 1-seriata, inferne e prope medium angustata, apice rotundo, pallide testacea, in siccis atrata, ad 5 mm., vel in flore majore 7 mm., longa, ad 1 mm. lata; staminodia appressa alba, stamina leviter excedentia; filamenta conice conferta, prope medium obscure papillata, 2 mm. longa; glandulae distantes crenulatae inconspicuae; ovarii lobi erecti obtusi, vix compressi, fere ad 1 mm. elevati; stigmata 5, anguste subulata, ca. ad 2 mm. longa cum cauda ca. 0·75 mm. longa.

Cape Province: in dit. Uitenhage; Despatch, *Fred H. Holland*. N.B.G. 678/25. Fl. Feb.—April 1929—1932.

***Delosperma wilmaniae*** Lavis sp. nov. (*Cymosa*—*Herbacea*).—Rami primarii 8 visi, ad 25 cm. longi, 2—4 mm. diam., copiose ramulosi, internodiis pallidis

vel albis, 1—5·7 cm. longis; ramuli floriferi ad 17 cm. longi, ad 3 mm. diam.; folia ascendunt vel patentia vel recurva, supra linearia concava, prope apicem angustata, obtusa, dorso rotundo, 2·5—4 cm. longa, ad 3 mm. diam.; cymae breves 2-ternatae, vel irregulariter ca. 5—6-ternatae, 9 cm. longae, ca. 5 cm. diam.; pedunculi saepius 0·5—1·5 cm. longi; receptaculum fere semiglobosum, 3 mm. longum, 5 mm. diam.; sepala 5, variabilia, subaequilonga, 2—3 mm. longa, basi 1·5 mm. lata, vel 4—8 mm. longa, basi 1·25—4 mm. lata, saepius obtusa; corolla 9—11 mm. diam.; petala ca. 2—3-seriata, alba, 4—5 mm. longa, ca. 0·5 mm. lata; staminodia nulla; filamenta 3-seriata, 1·5—2·5 mm. longa, antheris pollineque luteis; glandulae distantes conspicuae, atre virides; ovarii lobi stellate patentes, glandulas fere attingentes, obtuse compressi, ca. ad 0·75 mm. elevati; stigmata 5, 1·5 mm. longa cum cauda dimidium aequante; capsula infra obconica, 2·5—3 mm. longa, 2·5 mm., expansa, 5—6 mm., diam., supra ca. ad 1 mm. elevata, suturis compressis.

Cape Province: in dit. Griqualand West; prope Kimberley, "on the banks of the Modder River, on the Harris' farm Kalkdrift, the plants seem to last for only a few seasons." Fl. Jan.—May, 1927—1933, *M. Wilman*. Bolus Herbarium, 27810.

Ad *D. zoëam* valde affine, sed receptaculo fere semigloboso, petalis angustioribus, staminodiis absentibus, filamentis epapillatis, differt.

Described partly from the dried specimens that flowered on the fine rockery near the Kimberley Museum, a living memorial of Miss Maria Wilman's manifold achievements during her long curatorship of the Kimberley Museum. Our dissections were made from living plants, as were those also, together with her drawings, of Miss B. O. Carter.

Note.—The type specimens of all new species described in this paper are in the Bolus Herbarium, University of Cape Town.

*(To be continued)*

# CYTOLOGICAL OBSERVATIONS ON HYPOXIS:

## I. SOMATIC CHROMOSOMES AND MEIOSIS IN SOME *HYPOXIS*\* SPECIES

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### ABSTRACT

Somatic chromosome numbers which varied from 16 to 96 were recorded for five "species" of *Hypoxis*. Meiosis was described in three "species" and in all three cases abnormalities (precocious chromosomes, laggards, multivalents and univalents) were recorded. These data, and the morphological variation which exists in this genus, suggest the occurrence of apomixis.

*Hypoxis* species are quite common in most parts of Southern Africa, and after superficial study, it seems quite easy to recognise different species e.g. *H. rooperi*, *H. nitida*, *H. rigidula* and others. As soon as one studies natural occurring populations more closely, however, one notices practically all intermediate stages and it becomes much more difficult—in fact in most cases impossible—to decide where the morphological variation of the one species stops and where the other begins. It is for example often impossible to decide whether a given specimen belongs to *H. rooperi* or *H. rigidula*, because one can see all the intermediate stages to both *H. rooperi* and *H. rigidula* in the same community. The taxonomist tries to solve this problem by looking for clear-cut differences, and in this way Verdoorn (1948—49) described *H. nitida*, using

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\*After submitting this paper for publication the work of A. Fernandes and J. B. Neves (Sur la caryologie de quelques Monocotylédones africaines. Rendus IV<sup>e</sup> Réunion A.E.T.F.A.T. 1961: 439-464) has come to my notice. They also studied *Hypoxis rooperi* and reported that the species did not have a homogenous chromosome number because they found plants with 76 and 114 somatic chromosomes. ( $2n=76$  was confirmed by  $n=38$  determined in pollen mother cell meiosis and pollen mitosis.) The variation in chromosome number was neatly explained as being the result of different degrees of polyploidy (tetra- and hexaploidy with 19 as the basic number).

That  $2n=76$ , 96 and 114 have now been reported for this species does not surprise the present author. Not only are the plants most difficult to place into clear-cut species, but meiosis is abnormal and the plants are probably apomictic—in which case one can expect variation in chromosome number. I cannot accept the number  $2n=114$  without query as such high counts can seldom be claimed as anything but approximations. It is surprising that the authors did not report any meiotic abnormalities in *H. rooperi*, as they were very common in my specimens.

the easily recognisable character of seed coat appearance—shiny or non-shiny. There is, however, no evidence that this is a specific difference—it may just be that two alleles are present in “shiny” and “non-shiny” and it is quite possible that the dominant prevails in some populations and is rare in other populations. The hairiness of the leaves (another character used to describe this species) varies greatly in populations.

Most of the differences are not due to environment, because the different morphological types commonly occur in the same habitat.

The cytological observations recorded in these three papers were made in order to gain some understanding of the species problem in *Hypoxis*. These studies include a description of somatic chromosomes (root tips) and of meiosis in the pollen-mother-cells, of the gametophytic cells (divisions in the pollen tubes) and also of embryo sac development. The results are submitted in three papers and should be regarded as being preliminary reports only, pointing the way to intensive future research.

#### THE SOMATIC CHROMOSOMES OF SOME SPECIES

##### *Material and Methods*

The specimens were identified by the staff of the National Herbarium in Pretoria, but in some cases only tentative identification could be obtained (e.g. *Hypoxis* cf. *zeyheri*).

If the root tips of any *Hypoxis* specimens are fixed in fixatives containing chromic acid they become overchromated within minutes. This blackening is so intense that subsequent staining is useless. Fixations with fluids without chromic acid (e.g. Carnoy's and FAA) did not give satisfactory results, and fixatives containing osmic acid resulted in intense blackening of tissues within seconds.

As the different Navashin fixatives are very reliable, it was decided to persist with Randolph's modified Navashin fluid (as quoted by Johansen, 1940) and to bleach the material after sectioning, but the sections could not be bleached in hydrogen peroxide nor chlorine solutions. The only successful method was to dip the slides in a 1% aqueous potassium permanganate solution for one minute, followed by a quick wash in water and a subsequent wash for 2 minutes in oxalic acid.

Dehydration of material was done in a graded series of ethyl and n-butyl alcohol, embedded in paraffin wax and the sections were 10–15  $\mu$  in thickness. Best staining results were obtained by using crystal violet, using the method of Smith (1934). The drawings were made by using a net micrometer in the eyepiece.

##### *Somatic Chromosomes*

Five species have been investigated.



(a) *Hypoxis stellipilis* (Ker.). Collected in the Alice (C.P.) district. Figure 1a.  $2n = 16$ .

The chromosomes of *Hypoxis* species are generally small, but even so, the centromeres could clearly be seen in most cases. No secondary constrictions were recorded in any of the species. The chromosomes of *H. stellipilis* varied in length from 5 microns for the longest pair to under 2 microns for the shortest chromosome.

The centromeres are sub-medial in 5 pairs, sub-terminal in the remaining 3.

(b) *Hypoxis zeyheri* (?) Baker. Figure 1b.  $2n = 32$ .

The material was collected at the Hogsback in the Alice district. The specimens were named tentatively only, because they differed from the type description of *H. zeyheri* by having hairy leaves.

The chromosomes are shorter than in *H. stellipilis*, and the longest chromosomes at full metaphase are under 4 microns in length. There are four pairs of very short chromosomes in which the centromeres could not be seen, in four pairs the centromeres are very close to median, and in the others the centromere position is sub-medial to sub-terminal.

(c) *Hypoxis multiceps* Buchinge.  $2n = 36$ . Figure 1c.

The chromosomes vary in length from 5 to more or less  $1\frac{1}{2}$  microns. The centromere position could not be determined for the shortest chromosomes. The chromosomes were too numerous and small to enable one to recognise the different homologous pairs.

(d) *Hypoxis longifolia* Baker.  $2n = 72$ . Figure 1d.

The material was collected in the East London district.

Centromere positions could be recorded in most cases (Fig. 1d) but the genome is too complex for further analysis. Chromosome length varied from over 6 to under 2 microns.

(e) *Hypoxis rooperi* Moore.  $2n = 96$ . Figure 1e.

The material was collected close to East London. There are so many chromosomes, and so little variation in length that karyotype analyses becomes almost meaningless. Even the number recorded (96) must be considered as tentative only.

It is obvious from the above results that polyploidy has played an important role in speciation of these plants, but from the above recorded chromosome numbers it is impossible to suggest a basic number. Eight can be considered as the basic number for four of the species, but it cannot explain the  $2n = 36$ , which occurs in *H. multiceps*.

#### MEIOSIS IN THE ANTHERS OF HYPOXIS SPECIES.

Meiosis occurs before the inflorescences appear, and the plants produce



FIGURE 1: Metaphase plates in root tips of different *Hypoxis* species.  
 Fig. 1a: *H. stellipilis*,  $2n = 16$ . Fig. 1b: *H. zeyheri*,  $2n = 32$ .  
 Fig. 1c: *H. multiceps*,  $2n = 36$ . Fig. 1d: *H. longifolia*,  $2n = 72$ .  
 Fig. 1e: *H. rooperi*,  $2n = 96$ .

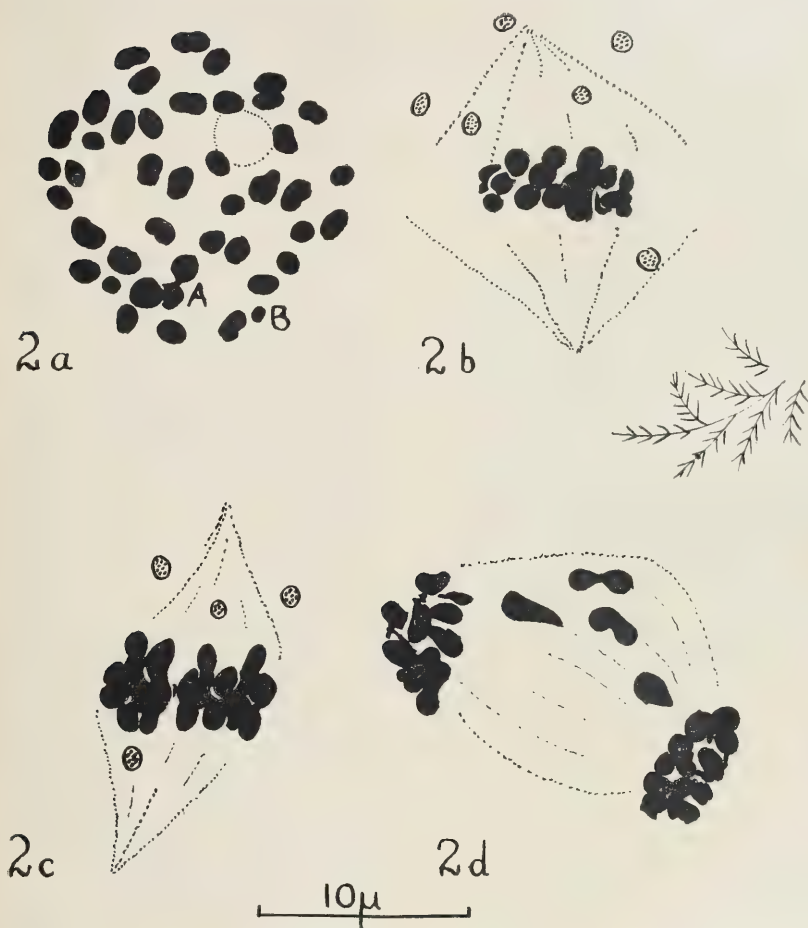


FIGURE 2: Meiosis in pollen mother cells of *Hypoxis nitida*.

Fig. 2a: Diakinesis,  $n = \pm 40-42$ . A—multivalent; B—univalent.

Fig. 2b: Metaphase I, with precocious univalents.

Fig. 2c: Metaphase I, with precocious univalents.

Fig. 2d: Late anaphase I, with laggards.

several inflorescences. Young flowers can be obtained when the first inflorescences appear by gripping the leaves firmly and pulling, which causes a break at the base of the leaves. Between these soft leaf bases several young inflorescences can be collected for meiotic studies.

The anthers were removed, smeared on a clean slide and immediately fixed and stained in aceto-carmin. The preparations were made semi-permanent by sealing the edges of the coverslip with nail varnish, and such slides were stored at plus or minus 4°C.

*Results:*

1. *Hypoxis nitida*:  $n = \pm 40-42$ .

In Fig. 2a (which represents diakinesis) one can see three bivalents which are associated with the nucleolus. *A* represents a multivalent and some small chromosome bodies, *B* may represent a univalent.

At metaphase some chromosomes, which are interpreted as univalents, move precociously (Figs. 2b, 2c) and at this stage they do not stain as deeply as the chromosome associations on the equatorial plate.

At anaphase laggards are practically always present. (Fig. 2d).

It is extremely difficult to determine the haploid chromosome number, but it appears to be between 40 and 42.

2. *Hypoxis rooperi* (Witwatersrand).

FIRST MEIOTIC DIVISION

*Diakinesis:*

Chromosome associations are here often so complicated that analysis of diakinesis fails—see e.g. at the configurations at E in Figs. 3a and 3b.

Multivalents are common e.g. a multivalent of 5 at *A* in Fig. 3b, of four at *B* in Fig. 3a, of 3 at *C* in Fig. 3b. Univalents also occur e.g. *D* in Fig. 3a.

The multivalents labelled E in Fig. 3a and 3b consist of more than 5 chromosomes.

*Metaphase:*

Most of the chromosome associations become orientated on the metaphase plate, but some univalents move precociously (*A* in Fig. 3c).

*Late Anaphase:*

When most of the chromosomes have reached the poles, several laggards are still present between the chromosome groups (see Fig. 3d and 3e). Some of the laggards consist of associations of 2 chromosomes (*A* in Fig. 3e), but in some cases multivalent associations lag behind the others, e.g. the lagging multivalent of 6 chromosomes in Fig. 3d.

*Telophase:*

Some of the laggards are not included when the new nuclei are formed (Fig. 3f).



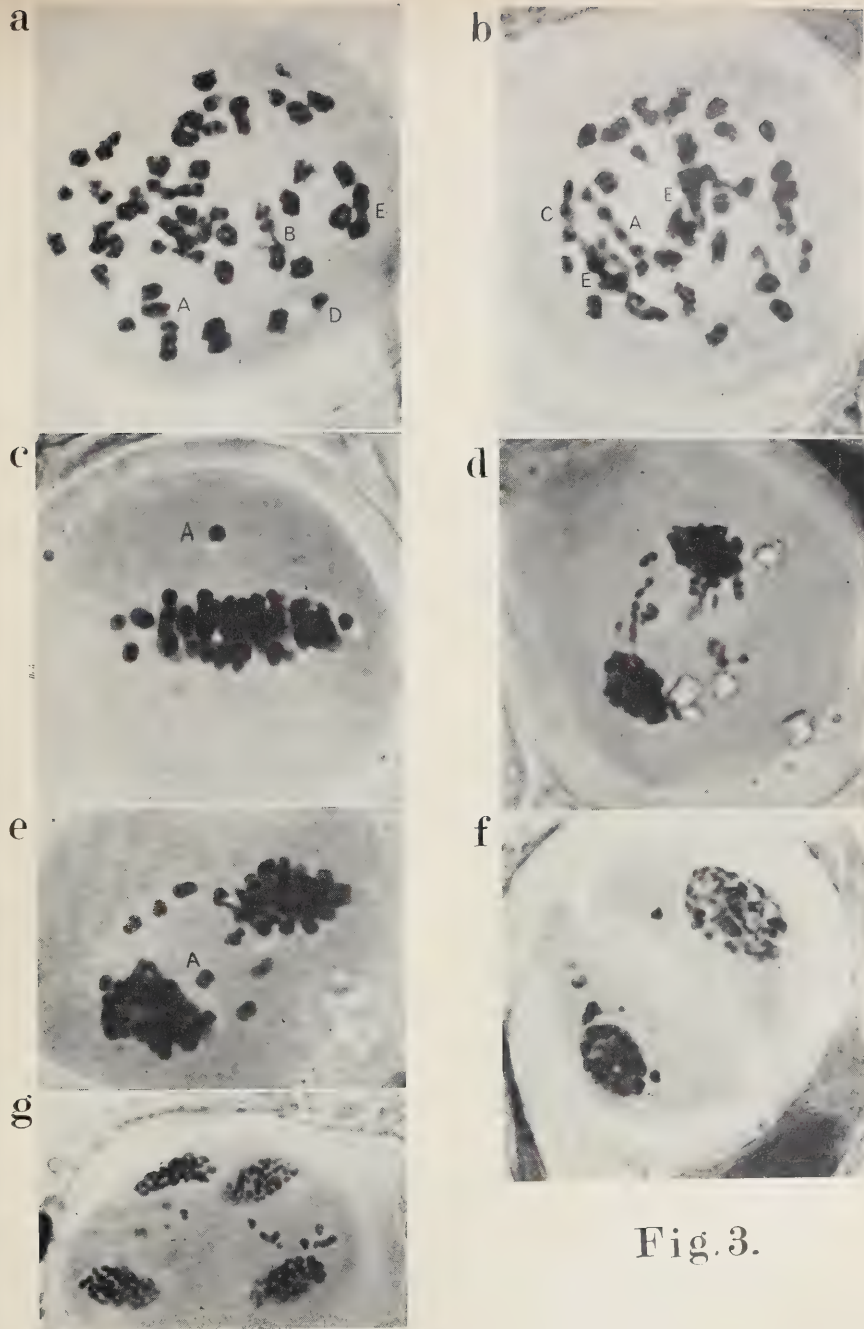


Fig. 3.

FIGURE 3: Meiosis in pollen mother cells of *Hypoxis rooperi*.

Figures 3a and 3b: Diakinesis. A: multivalent of 5 chromosomes; B: multivalent of 4 chromosomes; C: trivalent; D: univalent; E: complicated multivalents of more than 5 chromosomes.

Fig. 3c: Metaphase I with precocious univalents.

Fig. 3d: Late anaphase I, with laggards—one laggard of six chromosomes shows clearly.

Fig. 3e: Late anaphase I, with lagging bivalents.

Fig. 3f: Laggards being excluded from nuclei formed at telophase I.

Fig. 3g: Laggards being excluded from nuclei at telophase II.

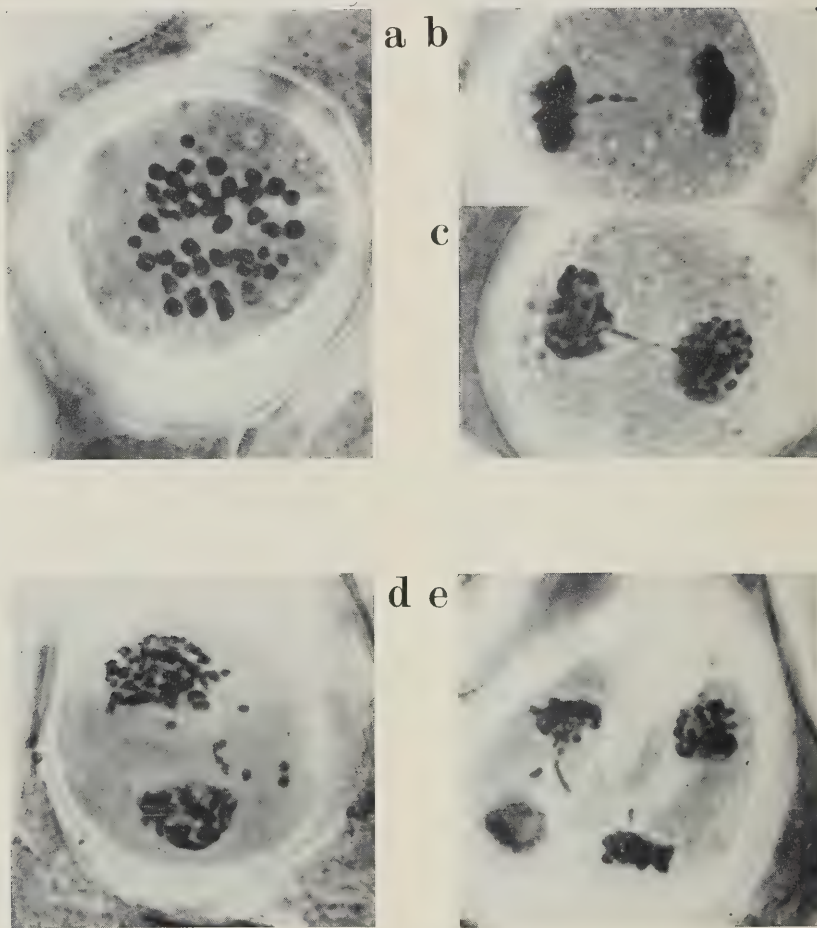


Fig. 4.

FIGURE 4: *Hypoxis* species.

Fig. 4a: Diakinesis.

Figs. 4b and 4c: Showing a lagging multivalent and a bridge at telophase I.

Fig. 4d: Chromosomes are excluded from nuclei at telophase I.

Fig. 4e: Laggard at telophase II.

#### SECOND MEIOTIC DIVISION

Several chromosomes are excluded from the nuclei which are formed at the second telophase (see Fig. 3g).

These abnormalities were recorded in *Hypoxis rooperi* specimens collected at Honeydew (District Roodepoort), but similar abnormalities were also seen in plants collected at Mondeor (District Johannesburg).

#### 3. *Hypoxis* species:

Fig. 4a represents diakinesis, and although multivalents and univalents are present the haploid chromosome number is more or less 40.

Precocious chromosomes are present at metaphase I, bridges and laggards are present at anaphase I and telophase I (Fig. 4b and 4c) and laggards are also present at telophase II (Fig. 4e). Some laggards are excluded from the nuclei that are formed at the end of meiosis I (Fig. 4d).

At metaphase I, 33% of the divisions were abnormal, at anaphase I, 46% and at anaphase II, 48%.

#### DISCUSSION

It is clear that polyploidy has played an important role during speciation in the genus *Hypoxis*, but from the results presented here it is impossible to determine the basic chromosome number. The basic chromosome number is most likely below 9 because at least one species has 16 somatic chromosomes.

There are such numerous abnormalities during meiosis of the high chromosome-number species that one would expect a high degree of sterility if the plants were reproducing sexually. This is not the case, because the capsules have numerous healthy seeds.

The high polyploidy, abnormal meiosis and morphological variation (which occurs within a species) are indicative of apomixis occurring in this genus. If apomixis occurs, then pollination is still necessary because in several experiments when flowers were emasculated and bagged no further development of the ovules took place.

If these plants are apomictic, all the seeds from one plant will develop into similar individuals, whereas if hybridization is very common (which could also explain the morphological variation and abnormal meiosis) great variation will be seen in such offspring. In several experiments in our department in which seeds were planted, not a single one germinated although several conventional methods of overcoming seed dormancy were tried (e.g. alternate freezing and thawing, alternate periods of light and dark, chipping and abrading the testa, soaking seed in  $H_2SO_4$ ). After trying these methods to germinate seed a paper

by Markotter (1936) came to our notice, in which he germinated seed of the closely related genera *Forbesia*, *Pauridia* and *Ianthe*, and in which he demonstrated that these seeds required an after-ripening period of a year. This would explain the negative results obtained in our department.

This long after-ripening period makes progeny-testing time consuming. The hypothesis that several *Hypoxis* species are apomictic was tested by embryo-sac analysis. This will be reported in a later paper.

#### ACKNOWLEDGEMENTS

The author wishes to express his appreciation and acknowledgement of the contributions to the study which were made by Miss A. Godfrey and Mr. A. Joubert. Miss Godfrey made the determinations of percentage abnormalities in meiosis of *Hypoxis species*, and Mr. Joubert made the preparations of pollen mother cells of *Hypoxis rooperii*.

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SOME NEW SPECIES OF LEUCADENDRON

ION WILLIAMS

ABSTRACT

This paper contains descriptions of four species of *Leucadendron*. *L. laxum* is a species close to *L. corymbosum* Berg. and abundant in the Bredasdorp Division. *L. loeriense* is from the mountains of the Humansdorp Division. *L. nobile* also from the Humansdorp Division is a striking shrub up to 12 feet high with needle-like leaves, apparently confined to one small area. *L. singulare* from the summit of the Mannetjiesberg in the Uniondale Division, is in some ways a rather unusual species. It has been necessary to propose a new combination in order to complete the description of *L. nobile*.

***Leucadendron teretifolium*** (Andr.) Williams comb. nov.

*Protea teretifolia* Andrews Bot. Rep. 7: 461 (1807).

*Chasme teretifolia* Salisb. ex Knight Prot. 16 (1809).

*Leucadendron abietinum* R. Br. in Trans. Linn. Soc. 10: 64 (1810).

LECTOTYPE. Plate 461 in Andr. Bot. Rep. (1807).

Andrews' plate shews two enlarged male flower heads on the same plant as the mature female cone. The artist was evidently trying to imagine the appearance of the female head when in bloom. The small figure below shews the correct male inflorescence. According to Knight Prot. 16 (1809) this plant was introduced by Mr. J. Niven. Niven's collection No. 62 (LINN) is No. 156-8 in Smith's Herbarium.

***Leucadendron laxum*** Williams. sp. nov. (Proteaceae) affinis *L. corymboso* Berg. sed ita differt caules foliis capitulisque parviore, rami laxi non rigidi, folia caulina erecto-patens, pili apicales bractearum masculinarum minus quam 1 mm longi, anthera ad apicem nigra.

*Shrubs* up to 1·5 m, erect, a single stem at ground level, many short foliaceous branches at the base, flowers numerous, borne on the erect branches in scattered groups. *Branches* tomentose, purplish, slender, slightly stouter in the female, not hidden by the leaves. *Branchlets* numerous, very slender, short usually



PLATE 1.  
*L. laxum* ♂ habit.

occurring in groups at intervals on the main branches. *Foliaceous branchlets* very slender, lax, with a few weak hairs. *Leaves* acicular, almost oval in cross-section, glabrous, sparsely villous when young, patulate-erect, mucronate, evenly spaced, males up to 13.5 mm long and 1.25 mm diam, females up to 17.5 mm long and 1.3 mm wide, much smaller on branchlets, more slender on the lower foliaceous branchlets. *Male Inflorescence* numerous, exceeding the leaves, solitary or sometimes 3-nate at the ends of short or very short groups of branchlets, depressed globose, about 6 mm long and 9 mm diam, peduncle 5 mm long. *Basal bracts* narrowly lanceolate, glabrous, ciliate, about 5 mm long, about 20 in number mostly grouped at the base of the peduncle, a few smaller scattered above. *Floral bracts* 1.5 mm long, 1 mm broad, ovate, hollow, translucent, glabrous, ciliate, apical cilia less than 1 mm long. *Floral bud* 4.25 mm long, slightly bent, pubescent, yellow and glabrous above. *Perianth tube* terete, pubescent, 2 mm long. *Claw* pubescent, recurved 90—120°, 1.5 mm long. *Limb* glabrous, spatulate, 1.25 mm long. *Anthers* erect, curled

upwards, .75 mm long, connective dark brown visible at the apex as a minute dark spot. *Pollen* triangular in polar view with straight sides and blunt angles, sides .035 mm long, polar thickness .02 mm. *Style* filiform, glabrous, 3.5 mm long. *Stigma* abortive, clavate, minutely cleft, 0.6 mm long, acts as a pollen presenter. *Hypogynous scales* filiform, 1.5 mm long. *Female Inflorescence* solitary, at the ends of groups of short branchlets, exceeding the leaves, conical with about 12 small flowers in the flattened apex. *Basal bracts* the lowest leaf-like but broader and ciliate at the base, becoming lanceolate, acute, villous, ciliate, about 6.5 mm long and 2 mm broad arising from the pubescent lower sides of the head, about 18 in number. *Floral bracts* lingulate, acute, recurved and glabrous above, thickened and densely pubescent below, lanceolate, weakly ciliate, 5 mm long, 3.5 mm broad. *Floral buds* villous, straight, green, 6 mm long. *Perianth tube* transversely compressed, villous, glabrous and divided below, 3.5 mm long. *Claw* villous, recurved about 90°, 1 mm long. *Limb* linear, glabrous above, 1 mm long. *Staminodes* 0.3 mm long, absent from the anterior



PLATE 2.  
*L. laxum* ♀ habit.

segment. *Ovary* ovoid, densely clothed in thick watery hairs, .75 mm long, 0.5 mm broad. *Style* glabrous, straight, narrowing slightly below, 3.5 mm long. *Stigma* terminal, truncate, somewhat cleft, .5 mm broad. *Hypogynous scales* linear, 1.5 mm long. *Mature female cone* ovoid, pubescent, the acute glabrous elevated apices of the bracts are conspicuous, 20 mm long and 14 mm diam. *Fruit* a nut, biconvex, obovoid, tapering to the base, fringed with short hairs, anterior surface mottled, posterior surface divided vertically by a low ridge, 5 mm long, 3.5 mm broad.

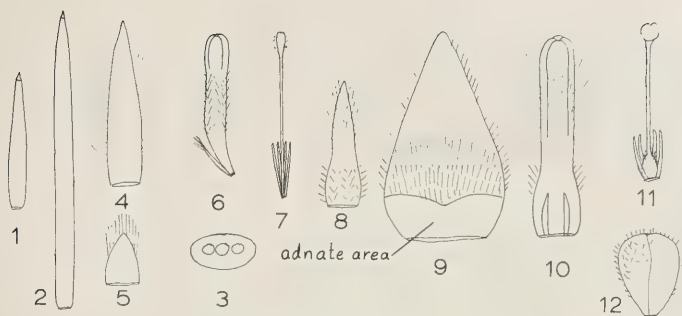
CAPE PROVINCE. Bredasdorp Division; Karsrivier, Ludwig 15 (NY, PRE, SAM). Near Bredasdorp, *L. Bolus* (BOL 20574), *Galpin* 10475 (K, P, PRE), Codd 9936 (K, NBG, PRE), *Garside* 4674 (K), *Muir* 5205, 5206 (PRE, NBG), *Acocks & Halfstrom* 2103 (PRE, S), *Breach* SAM (51338). The Poort, *Leighton* (BOL 21109), *Compton* 4388 (BOL), *Acocks* 1546 (S). Agulhas, *Ecklon* s.n. (P), *Marloth* 10016 (PRE). Near Elim, *Schlechter* 7617 (GRA). *H. Bolus* 7856 (BOL, K), *Compton* 19001 (NGB), 22635 (BOL, NBG), *Leighton* 2559 (NY), *Henderson* 1818 A (NGB). Elandskloof, *Ecklon* s.n. (P), *Jordaan* 936 (STE). Baardscheedersbos, *Gill* 100, 128 (NGB). *Thomas* s.n. (NGB), *Van Breda* 718 (PRE), *Stokoe* (SAM 65176), *Williams* 63 (NGB). Stanford/Elim *Barker* s.n. (BOL), *Gillett* 4356 (PRE). Avoca, *Williams* 286 (Holotype) (NGB). Caledon Division; *Hermanus*, *Patterson* s.n. (BOL). Stanford, *Wood* s.n. (NGB), *Williams* 78 (NGB).

*Leucadendron laxum* was collected first by Baron von Ludwig in the "Ruggens near Karsrivier" in the Bredasdorp District and subsequently by many others. Geographically it is found only in an area extending from Stanford to Bredasdorp which is quite far removed from that of *L. corymbosum* Berg which occurs in the vicinity of Paarl, Wolseley and Malmesbury. Although very close to *L. corymbosum* it differs in the following ways: 1. being smaller in many ways i.e. the stems are shorter and more slender, the leaves are shorter and narrower, the male flower heads are smaller; 2. the branches are lax and not rigidly erect; 3. the stem leaves are less erect; 4. the apical bristles on the male floral bract less than 1 mm long; 5. the connective dusky, providing the anther with a small black apex.

***Leucadendron loeriense* Williams sp. nov.**

*Frutex* 60 cm altus, ad basim 1-caulis, rubescens; *rami* laxi, erecto-villosi; *folia* 3.0—3.5 cm longa, 3.5—5.5 mm lata, anguste-oblonga, semi-patula, atroviridia, ubique erecto-pubescentia, ad apice sub-acuta obtusi-mucronulata, ad basim torta; *folia involucralia* conferta, anguste lanceolata, albescencia, apices versus contracta acuta, capitulum excedens; *inflorescentia mascula* 1.5 cm longa, 1.2 cm diam, ovoidea; *bracteola* 1.5 mm longa, 1 mm lata, ovalis, ciliata; *tubus perianthii* 1.5 mm longus, pubescens; *unguis* 1.5 mm



FIG. 1. *L. laxum*.

- |  |   |
|--|---|
| 1. a male leaf $\times 2.5$ .                                | 8. a female basal bract $\times 2.5$ .                  |
| 2. a female leaf $\times 2.5$ .                              | 9. a female floral bract $\times 5$ .                   |
| 3. section of a leaf $\times 10$ .                           | 10. a female bud $\times 5$ .                           |
| 4. a male basal bract $\times 5$ .                           | 11. a female pistil with hypogynous scales $\times 5$ . |
| 5. a male floral bract $\times 5$ .                          | 12. a fruit $\times 2.5$ .                              |
| 6. a male bud with bract $\times 5$ .                        |   |
| 7. a male sterile pistil with hypogynous scales $\times 5$ . |   |

longus, pubescens; *limbus* 1.5 mm longus, glaber; *anthera* 1.3 mm longa, decumbens; *pollen* aspectu polari triangulare .029 mm latum, altitudine polari .020 mm; *stylus* 3 mm longus, glaber; *stigma abortivum* 1.3 mm longum, clavatum; *squama hypogyna* 1.3 mm longa, subulata; *receptaculum* 1.3 cm longum, 3.5 mm diam, cylindricum; *inflorescentia femina* 1.3 cm longa, 1 cm diam, ovoidea; *bracteola* 2.5 mm longa, 5 mm lata, late ovalis, dense brevi-pubescens, ciliata; *tubus perianthii* 2.5 mm longus, pubescens. ad basim glaber et divisus; *unguis* .75 mm longus, pubescens; *limbus* .75 mm longus, glaber; *staminodium* .5 mm longum, anticum saepe absens; *ovarium* .75 mm longum, bilobatum, glabrum; *stylus* 3 mm longus, glaber; *stigma* .5 mm latum, truncatum, sub-obliquum; *squama hypogyna* 1.3 mm longa, lata, obtusa; *receptaculum* 1.2 cm longum, 2.5 mm diam, anguste conicum; *strobilus* femineus maturus 2.5 cm longus, 2.0 cm diam, globosus; *samara* 6 mm longa, 5 mm lata, fusca, foveolata, emarginata, ad apice alata.

*Shrubs* rather low, 60 cm after 2 years, tinged with red, fairly densely branched from a single stem below, with few erect stems. *Branches* lax, purplish, somewhat slender, villous. *Leaves* narrowly-oblong, semi-patulate, dark green, covered on all sides with a velvety erect pubescence, apex sub-acute with a small blunt mucro, twisted and narrowed at the base, subequal in the two sexes, 3.0—3.5 cm long, 3.5—5.5 mm broad. *Involucral leaves* crowded, narrowly lanceolate, greenish white, becoming glabrous on the inner surface and decreasing in size towards the head, tapering to a small blunt mucro at



the acute apex, about 16 in number, forming a starlike cup around and exceeding the head. *Male Inflorescence* solitary, terminal, conical when in bud, 1.5 cm long, 1.2 cm diam, flowers arranged in 21 ascending spiral rows. *Basal bracts* ovate, acute, glabrous, ciliate, 5 mm long, 3 mm broad about 6 in number. *Floral bract* oval, ciliate, sparsely pubescent on the upper part of the midrib, 1.5 mm long, 1 mm broad. *Floral bud* 4.5 mm long, glabrous at the apex and base, otherwise pubescent, apex somewhat enlarged, standing in a tuft of hairs. *Perianth tube* 1.5 mm long, pubescent above, glabrous below. *Claw* 1.5 mm long, pubescent, recurved more than  $90^\circ$ . *Limb* 1.5 mm long, glabrous above, pubescent at the base, oblong. *Anther* 1.3 mm long, decumbent. *Stigma* abortive, 1.3 mm long, clavate, acts as a pollen presenter. *Style* 3 mm long, glabrous, narrower above. *Hypogynous scales* 1.3 mm long, subulate, yellow. *Nectar* seen at the apices of the Hypogynous scales in the throat of the perianth tube. *Pollen* triangular in polar view with obtuse apices, sides .029 mm long, polar thickness .020 mm. *Receptacle* 1.3 cm long, 3.5 mm diam, cylindrical. *Female*



PLATE 3.  
*L. loeriense* habit.



PLATE 4.  
*L. singulare* habit.

*Inflorescence* solitary, terminal, with or without a colourful involucre, ovoid, 1.3 cm long, 1 cm diam, with flowers in 8 ascending spirals. *Basal bracts* similar to the male. *Floral bract* 2.5 mm long, 5 mm broad, broadly oval, densely short pubescent in the upper two thirds, glabrous across the base, ciliate. *Floral bud* 4.5 mm long, transversely flattened, rounded and glabrous above, divided and glabrous below, mid section pubescent. *Perianth tube* 2.5 mm long, weakly fused, pubescent above, glabrous and divided below. *Claw* .75 mm long, pubescent, recurved  $145^\circ$  and more. *Limb* .75 mm long, glabrous, posterior much thickened at the apex, anterior flattened. *Staminodes* .5 mm long, anterior usually absent. *Ovary* .75 mm long, glabrous, bilobed above. *Stigma* .5 mm broad, truncate, sub-oblique. *Style* 3 mm long, glabrous, narrower below. *Hypogynous scales* 1.3 mm long, yellow, broad, tapering, obtuse. *Nectar* seen at the apices of the hypogynous scales and in the throat of the perianth tube. *Receptacle* 1.2 cm long, 2.5 mm diam, narrowly conical. *Mature*

*female head* a cone 2.5 cm long, 2.0 cm diam, globose, with bracts reddened and glabrous above, densely pubescent across the middle. *Fruit* a samara, 6 mm long, 5 mm broad, compressed, black, pitted, ribbed on the inside, emarginate and winged above.

CAPE PROVINCE. Humansdorp Division, Loerie Forest Reserve, *Williams* 962 (Holotype) (NBG), 454 (NBG). Otterford Forest Reserve, *Middelmann* 5 (NBG). Mac Peak, Baviaanskloof Mts., *Taylor* 941b (NBG). Uitenhage Division, Cockscomb, Great Winterhoek Mts., *Esterhuysen* 27110 (BOL), 28022 (BOL).

The species here described was grown at Hermanus from the seed collected (29/6/64) at Loerie Forest Reserve on the Van Stadensberg. They were sown on the 3/8/64, planted out on the 8/3/65 and bloomed for the first time on the 20/11/66 continuing in bloom throughout December and into January. *L. loeriense* can be distinguished from *L. uliginosum* R. Br. by being a low shrub and never tall, by having leaves with an erect and not adpressed pubescence, by having a reddish and not a silvery tinge and by having fruits that are broadly not narrowly winged towards the apex. *L. radiatum* Phill. & Hutch. has leaves that are very much more twisted. Just as *L. floridum* R. Br. is a far Western relative of *L. uliginosum* R. Br. so *L. loeriense* is its far Eastern congener. *L. loeriense* is insect pollinated having nectar, a conspicuous involucre, a pollen presenter in the male and a very small stigmatic surface in the female.

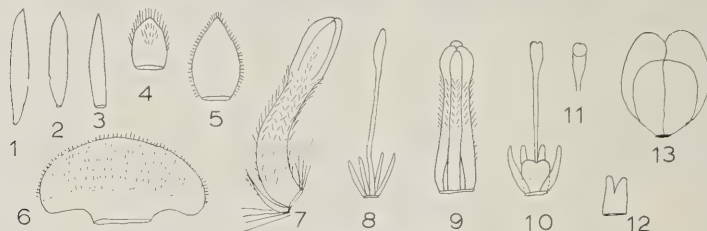


FIG. 2. *L. loeriense*.

- |   |   |
|---|---|
| 1. a male leaf half size.                                     | 9. a female bud $\times 5$ .  |
| 2. a female leaf half size.                                   | 10. posterior view of a female pistil with hypogynous scales $\times 5$ . |
| 3. a male involucral leaf half size.                          | 11. anterior view of the stigma $\times 5$ .                              |
| 4. a male floral bract $\times 5$ .                           | 12. anterior hypogynous scales (occasionally connate) $\times 5$ .        |
| 5. a male basal bract $\times 2.5$ .                          | 13. fruit $\times 2.5$ .  |
| 6. a female floral bract $\times 5$ .                         |   |
| 7. a male bud $\times 5$ .                                    |   |
| 8. a male abortive pistil with hypogynous scales $\times 5$ . |   |

***Leucadendron nobile* Williams sp. nov.**

*Frutex* 3 m altus, erectus; *rami recti*, glabri; *folia teretia* glabra, mucronata, maribus ad 3.2 cm longis, feminis ad 5.8 cm longis; *inflorescentia masculina*

3·3 cm longa, 1 cm diam, solitaria, terminalis, spicata, glabra, pedunculata; *bracteola* glabra; *perianthii tubus* 1 mm longus, glaber; *unguis* 3 mm longus, glaber; *limbus* 2 mm longus, glaber; *anthera* 1·5 mm longa; *stylus* 4 mm longus, glaber; *stigma abortivum* 1·5 mm longum, bifidum, clavatum; *squamae hypogynae* 1 mm longae, crassae; *receptaculum* 2·5 cm longum, 1·5 mm diam, anguste cylindricum; *inflorescentia feminea* 2·8 cm longa, 1·2 cm diam, solitaria, terminalia, anguste ovoidea, pedunculata; *bracteola* 2·5 mm longa, 4·2 mm lata, glabra; *perianthii tubus* 2·5 mm longus, compressus, sparsim pubescens; *unguis* 1·2 mm longus, sparsim pubescens; *limbus* 1 mm longus, glaber; *staminodium* ·5 mm longum; *filamentum* distinctum ad apicem; *ovarium* ·7 mm longum, ovoideum, glabrum; *stylus* 3 mm longus, glaber; *stigma* ·3 mm diam, obliquum; *squamae hypogynae* 1 mm longae, crassae; *receptaculum* 2 cm longum, 5 mm diam; *strobilus maturus* 4—9 cm longus, 2·4—3·9 cm diam, glaber; *samara* 7 mm longa, 6 mm lata, cordata, emarginata, anguste alata. Species proprissima propter altitudinem folia longa teretia capitulaque pedunculata.

*Shrubs* up to 4 m, single stemmed at the base but branching immediately into several stout erect stems with a smooth light grey bark; males not as robust but more branched. *Branches* straight, erect, stout in females, often purplish. *Leaves* terete, glabrous, mucronate, slightly grooved on the upper surface, semi-patulate, males up to 4·1 cm long and 1·2 mm diam, females up to 5·8 cm long and 1·5 mm diam. *Involucral leaves* similar to the stem leaves, pale green to ivory in colour, not much crowded, not concealing the head. *Male Inflorescence* 4 cm long and 1 cm diam, solitary, terminal, spicate, glabrous, pedunculate, exhaling an unpleasant odour. *Basal bracts* clothing the peduncle, 5 mm long and 1·2 mm broad, glabrous, short ciliate, swollen at the base, tapering to the acute apex, about 30 in number. *Floral bracts* 1·3 mm long and 1·3 mm broad, acute, short ciliate standing with the floret on a swollen base. *Floral bud* 5 mm long, straight, erect, glabrous except for a few short hairs, green, not much swollen at the apex. *Perianth tube* 1 mm long, glabrous except for a few short hairs on the lateral segments. *Claw* 3 mm long, glabrous, recurved 180°. *Limb* 2 mm long, glabrous, hollow. *Anther* 1·5 mm long, curling upward. *Abortive stigma* 1·5 mm long, clavate, often minutely bifid, acts as a pollen presenter. *Style* 4 mm long, glabrous. *Hypogynous scales* 1 mm long, stout, pale yellow, exuding nectar at the apex. *Pollen* triangular in polar view with sides ·03 mm long, polar depth ·02 mm. *Receptacle* 3·5 cm long and 1·5 mm diam, narrowly cylindrical. *Female Inflorescence* 2·8 cm long and 1·2 cm diam, solitary, terminal, elongated-ovoid, exhaling an unpleasant musty odour, growing in length as the florets open progressively towards the apex, with the florets arranged in 13 ascending spirals of about



11 in each, with a stout peduncle 8 mm long. *Basal bracts* 7 mm long and 2·5 mm broad, caudate, glabrous, short ciliate, imbricating the peduncle, about 34 in number. *Floral bracts* 2·5 mm long and 4·2 mm broad, broadly oval, glabrous, sparsely short ciliate, connate towards the base. *Floral bud* 4·7 mm long, compressed, tapering to the blunt glabrous apex, sparsely pubescent. *Perianth tube* 2·5 mm long, compressed, sparsely short pubescent. *Claw* 1·2 mm long, sparsely short pubescent, recurved 90°. *Limb* 1 mm long, glabrous. *Staminode* ·5 mm long. *Filament* distinct from the perianth segment above. *Ovary* ·7 mm long, ovoid, glabrous. *Style* 3 mm long, glabrous. *Stigma* ·3 mm diam, oblique. *Hypogynous scales* 1 mm long, stout, pale yellow. *Nectar* secreted from the apex of the scale is transferred to the throat of the perianth tube in the groove at the junction of the adjacent perianth segments. *Receptacle* 2 cm long and 5 mm diam, cylindrical. *Mature female head* cone-like, indehiscent, 4—9 cm long and 2·4—3·9 cm diam, with many closely spaced glabrous bracts arranged in three



PLATE 5.  
*L. nobile* ♂.

adnate spirals. *Fruit* a samara, 7 mm long and 6 mm broad, narrowly winged, dusky or mottled, flat, heart shaped, emarginate.

CAPE PROVINCE. Humansdorp Division, Guerna Kop South slopes 1,500—2,000 ft, *Vogts* 381 (PRE), *Williams* 722 (NBG), 982 (NBG (Holotype), BOL, STE, K, PRE), *Rourke* 619 (NBG).

*Leucadendron nobile* was first collected by Mrs. Marie M. Vogts (381 PRE) on the south slopes of Guerna Kop in the Humansdorp Division in May 1965 and up to now it has not been seen anywhere else. It is locally abundant and has fortunately escaped burning for many years, becoming a tall striking shrub with its needle like leaves and reddish cones seen at the tops of the branches against the blue sky. *Protea neriifolia* R. Br. and a very good red form of *P. repens* L. are extremely frequent in this area which also has a large cycad population. Being possessed of nectar, perfume, a pollen presenter in the male and a very small stigma in the female there can be no doubt that *L. nobile* is insect pollinated. It grows on steep dry gravelly T.M.S. south slopes flowering in December



PLATE 6.  
*L. nobile* ♀.

although one or two male flowers can be found as early as October and as late as March. *L. nobile* is easily distinguished from all other species of *Leucadendron* by its tall habit, long needle-like leaves and pedunculate heads. It is closest to *L. teretifolium* (Andr.) Williams comb. nov. (*L. abietinum* R. Br.) which is in every way smaller and to *L. muirii* Phillips which, growing on limestone, has thick broad leaves.

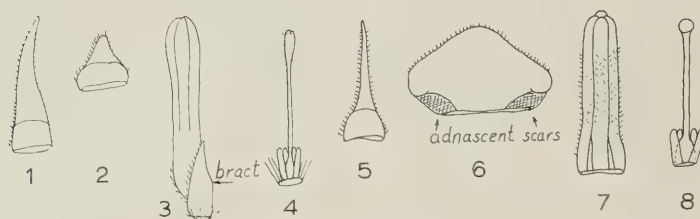


FIG. 3. *L. nobile*.

- |   |   |
|---|---|
| 1. a male basal bract $\times 5$ .                      | 5. a female basal bract $\times 2.5$ .                    |
| 2. a male floral bract $\times 5$ .                     | 6. a female floral bract $\times 5$ .                     |
| 3. a male floral bud with bract $\times 5$ .            | 7. a female floral bud $\times 5$ .                       |
| 4. a male pistil with hypogynous scales<br>$\times 5$ . | 8. a female pistil with hypogynous scales<br>$\times 5$ . |

***Leucadendron singulare* Williams sp. nov.**

*Frutex* 30 cm altus, humilis, argenteus; *rami* breves, graciles, breviter adpresso-pubescentes; *folia* 1.6 cm longa, 2.5 mm lata, linear-oblancoolata, argentea, adpresso-pubescentia; *inflorescentia masculina* 1.2 cm diam, globosa; *bractea basalis* 4 mm longa, 2.5 mm lata, late lanceolata, acuta, ciliata, breviter pubescens, numerosa; *bracteola* 3 mm longa, 1 mm lata, lanceolata, acuta, ad apicem caespitosa; *perianthii tubus* 1.5 mm longus, fere glaber; *unguis* 2 mm longus, dense pubescens; *limbus* 1.5 mm longus, dense pubescens; *anthera* 1 mm longa; *stylus* 3.5 mm longus, ad basim pubescens; *stigma abortivum* .8 mm longum, clavatum, minute bifidum; *squamae hypogynae* 1 mm longae, aciculares; *receptaculum* 4 mm diam, globosum; *pollen* aspectu polari triangulare .032 mm latum, altitudine polari .020 mm; *inflorescentia feminea* 14 mm longa, 18 mm diam, globosa, solitaria, terminalia; *bracteae basales* similes maribus, interiores latiores; *bracteola* 5 mm longa, 6.5 mm lata, late ovalis, apiculata, pubescens, longe ciliata; *perianthii tubus* 4 mm longus, pubescens, ad basim glaber et divisus; *unguis* 2 mm longus, pubescens; *limbus* 1 mm longus, pubescens; *staminodium* .7 mm longum; *ovarium* 1 mm longum, ovoideum, pubescens; *stylus* 4 mm longus, glaber; *stigma* .5 mm diam, truncatum, terminalia; *squamae hypogynae* 2 mm longae, aciculares; *receptaculum* 5 mm

diam, globosum; *strobilus maturus* 17 mm diam, globosus, pubescens; *nucula* 4.5 mm longa, 3.5 mm lata, obovoidea, sparsim breve pubescens.

*Shrubs* up to 30 cm, decumbent and spreading over rocks with a silvery hue. *Branches* short, slender, short adpressed pubescent when young. *Leaves* 1.6 cm long and 2.5 mm broad, oblanceolate-linear, narrowing somewhat towards the base, with a small blunt mucro at the subacute apex, covered on all sides by a short and dense adpressed pubescence. *Involucral leaves* similar to the stem leaves, not coloured but somewhat more crowded, not concealing the head. *Male Inflorescence* 1.2 cm diam, globose, solitary, terminal. *Basal bracts* 4 mm long, 2.5 mm broad, broadly lanceolate, acute, ciliate, shortly pubescent, about 30 in number. *Floral bracts* 3 mm long and 1 mm broad, lanceolate, acute, ciliate and tufted with hairs at the apex. *Floral bud* 4.5 mm long, densely pubescent, bent and glabrous at the base. *Perianth tube* 1.5 mm long, almost glabrous. *Claw* 2 mm long, densely pubescent, recurved 90°. *Limb* 1.5 mm long, densely pubescent. *Anthers* 1 mm long. *Abortive stigma* .8 mm long, clavate, minutely bifid, acts as a pollen presenter. *Style* 3.5 mm long, narrower and glabrous above, densely pubescent below. *Hypogynous scales* 1 mm long, acicular. *Receptacle* 4 mm diam, globose. *Pollen* triangular in polar view with sides .032 mm long, height of polar axis .02 mm. *Female Inflorescence* 14 mm long and 18 mm diam, solitary, terminal, globose. *Basal bracts* similar to the male but the innermost becoming broader. *Floral bracts* 5 mm long and 6.5 mm broad, broadly oval, apiculate, pubescent, long ciliate. *Floral bud* not seen. *Perianth tube* 4 mm long, pubescent above, glabrous and divided below. *Claw* 2 mm long, pubescent. *Limb* 1 mm long, pubescent, *Staminode* .7 mm long. *Ovary* 1 mm long, ovoid, pubescent. *Style* 4 mm long, glabrous. *Stigma* .5 mm diam, truncate, terminal. *Hypogynous scales* 2 mm long, acicular. *Receptacle* 5 mm diam, globose. *Mature female head* a cone 17 mm diam, globose, pubescent, dehiscent. *Fruit* a nutlet 4.5 mm long, 3.5 mm broad, obovoid, sparsely short pubescent.

CAPE PROVINCE. Uniondale Division, Mannetjiesberg 6,400 ft; Esterhuysen 6474 (Holotype) (BOL), 6600 (BOL), Williams 697 (NBG), Rourke (383) NBG.

*Leucadendron singulare* was collected in November 1941 by Miss Elsie Esterhuysen of the Bolus Herbarium near and on the summit of Mannetjiesberg in the Kammanassie Mountains. Botany in South Africa and the Bolus Herbarium in particular owe a great debt to this intrepid botanist whose collections from the most remote and inaccessible mountains have revealed countless species new to science. This extremely rare species is found growing in T.M.S. soil in between rocks against which it shelters on the exposed mountain tops at an altitude of 6,400 ft above sea level. Flowering in October and pollinated by insects, the fruits are ripe in February after which they fall to the ground.



*L. singulare* differs so much from all its congeners that I have chosen an epithet so as to express this peculiarity. Although the male looks very like a dwarf form of *L. album* (Thunb.) Fourcade (= *L. aurantiacum* Buek ex Meisn.) yet the female is vastly different with very much smaller leaves and perianth segments. There is a certain similarity with the heads of *L. sorocephalodes* Phill. & Hutch., but again the foliage is quite dis-similar; *L. sorocephalodes* having small glabrous subulate leaves. Any resemblance to *L. nitidum* Buek. ex Meisn. or to *L. sericeum* (Thunb.) R. Br. is purely superficial as these two species are basically so different from all other *Leucadendrons* as, almost to merit a separate generic name, having no hypogynous scales in the male and smooth oblong keeled fruits.

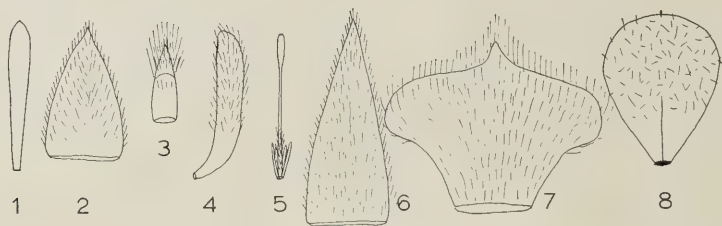


FIG. 4. *L. singulare*.

1. a leaf  $\times 1.5$ .
2. a male basal bract  $\times 5$ .
3. a male floral bract  $\times 5$ .
4. a male floral bud  $\times 5$ .

5. a male abortive pistil with hypogynous scales  $\times 5$ .
6. a female basal bract  $\times 5$ .
7. a female floral bract  $\times 5$ .
8. a fruit  $\times 5$ .

## STAPELIEAE FROM SOUTH TROPICAL AFRICA: IV.

L. C. LEACH AND D. C. H. PLOWES

Some confusion appears to have existed regarding the identities of *Caralluma carnosa* Stent and *C. keithii* R. A. Dyer together with its synonyms *C. fosteri* Pillans and *C. schweickerdtii* Obermeyer. This was apparently due mainly to the initial misidentification as *C. carnosa*, of a plant collected near Waterpoort, N. Transvaal (Obermeyer, Schweickerdt and Verdoorn 411) and to its being figured under that name in both Fl. Pl. S. Afr. (1935) and White & Sloane, Stapelieae (1937). Meanwhile it had been decided that it was an undescribed species and a description was published in Bothalia (1937) and in White & Sloane (*op. cit.*) under the name *C. schweickerdtii* with the consequent confusion of identities (this series of errors was subsequently discussed in Fl. Pl. Afr. (1950) when true *C. carnosa* was figured in that journal).

Examination of the various types involved, the study of living plants, both in the field and in cultivation, as well as of herbarium material, has made it possible to publish the following clarification of the position.

The distribution of *Caralluma carnosa* appears to be confined to a relatively small area of the Transvaal, mainly in the Waterberg, while that of the closely related *C. keithii* is widely scattered, extending from Natal in the south to Umtali, Rhodesia, in the north, with its known westerly limit on the Limpopo River in the Potgietersrust District of the Transvaal.

Although these taxa are both extremely variable in many characters and while neither seems to have any ecological or edaphic preferences (*C. keithii* particularly may be found growing under a wide range of conditions) there are, in addition to spatial separation, important constant morphological differences by which they may be readily distinguished; it is therefore considered that specific status should be retained.

The significant characters, the most important being perhaps the size and shape of the pollinia, are tabulated below, followed by others which are less constant but by which the species may be recognised in the majority of cases.

<i>C. carnosa</i>	<i>C. keithii</i>
Corolla small, usually <i>c</i> 0.8 cm diam (0.6 to 1 cm).	Corolla large, usually <i>c</i> 1.6 cm diam (1 to 2 cm).
Corolla white, cream, pale greyish green or buff with brown to maroon markings.	Corolla always deep maroon with creamy white markings (one specimen has been seen in which the corolla is maroon without markings).
Pollinia $\pm$ compressed ovoid, <i>c</i> 0.4 mm $\times$ 0.25 mm.	Pollinia $\pm$ flattened semicircular or obtusely triangular in outline, <i>c</i> 0.6 mm $\times$ 0.4 to 0.5 mm.

Corolla usually only lightly rugulose, with short simple hairs, usually not at all ciliate.

Inner corona lobes often shorter than the anthers.

Corona sessile.

Corolla heavily rugulose, usually with various kinds of long and short hairs, always, at least to some extent, ciliate.

Inner corona lobes usually at least as long as the anthers.

Corona usually somewhat stipitate.

The intersepal flagellae, at one time thought to be diagnostic, are present in both species although exceeding the sinuses (and so becoming visible) far less frequently in *C. carnosa* than in *C. keithii*.

***Caralluma carnosa*** Stent, in Kew Bull. 1916: 42 (1916).—White & Sloane, Stapelieae 1: 288, pro parte excl. Pl. 3 et fig. 222 (1937).—Phillips, Fl. Pl. Afr. 28: t. 1085 (1950).—Luckhoff, Stap. S. Afr.: 36 (1952).—Jacobsen, Handb. Succ. Pl. 1: 242 (1960). Type: Transvaal, Pretoria Distr., *Pole-Evans* 11020 (PRE, holo.).

SOUTH AFRICA. Transvaal: Waterberg Distr., Krantzberg, *Codd & Erens* 2064 (PRE); Malmanieshoek, *Hardy* 936 (PRE) idem. hort. *Leach* 12152 (K; SRGH); Vaalwater, *Theron* s.n. (PRE), Pretoria Distr., Zilikat's Nek, *Pole-Evans*, 11020 in Herb. Agr. Dept. (PRE) & 27739 in Herb. Bolus. (BOL); ibid. *Obermeyer* s.n. (PRE), *Verdoorn & Dyer* 3395 (PRE). Rustenburg Distr., prope Hartebeestepoort Dam, *Mogg* s.n. (PRE); Krantzberg Mtns., *Knobel* s.n. (PRE), ibid. *Codd* 3740A (PRE), *Erens* s.n. (PRE).

There is considerable variation in the size of the flowers and in the colouring of the corolla of *C. carnosa*; these variations often being apparent between

individuals in a single population, as is evidenced by the gathering from Vaalwater (see photo). The degree of hairiness and ciliation is also quite variable although usually the hairs are limited to a few short simple bristles while cilia are very rarely present and then only sparsely.



*Photo: Botanical Research Institute, Pretoria.*

***Caralluma carnosa*** Stent, Vaalwater, Waterberg Distr., *Theron* s.n. (PRE).  $\times$  approx.  $\cdot 5$

***Caralluma keithii*** R. A. Dyer in Fl. Pl. S. Afr. **15**: t. 600 (1935).—White & Sloane, *Stapeliteae* **1**: 290 (1937).—Luckhoff, *Stap. S. Afr.*: 37 (1952).—Jacobsen, *Handb. Succ. Pl.* **1**: 248 (1960). Type: Swaziland, Ubombo Mtns., *Keith* s.n., 19790 in Nat. Herb. (PRE, holo.).

***Caralluma fosteri*** Pillans in White & Sloane, *tom. cit.*: 292 (1937).—Jacobsen, *tom. cit.*: 246 (1960). Type: Transvaal, Lydenburg Distr., *Foster* s.n., 21311 in Herb. Bolus. (BOL).



*Caralluma schweickerdtii* Obermeyer in *Bothalia* 3: 250 (1937) & in White & Sloane, tom. cit.: 294 (1937).—Hutch. Bot. S. Afr.: 671 (1949).—Luckhoff, loc. cit. (1952).—Jacobsen, tom. cit.: 255 (1960). Type: Transvaal, Zoutpansberg Distr., Obermeyer, Schweickerdt & Verdoorn 411 (PRE).

*Caralluma carnosa* sensu Schweickerdt in Fl. Pl. S. Afr. 15: t. 592 (1935) & White & Sloane, tom. cit., pro parte quoad Pl. 3 et fig. 222 (1937), non Stent. Type as above.

SWAZILAND. Ubombo Range, 20 mls S. Stegi: Keith s.n. 19790 in Nat. Herb. (PRE); 35 mls S. Stegi, Leach & Bayliss 10649 (SRGH).

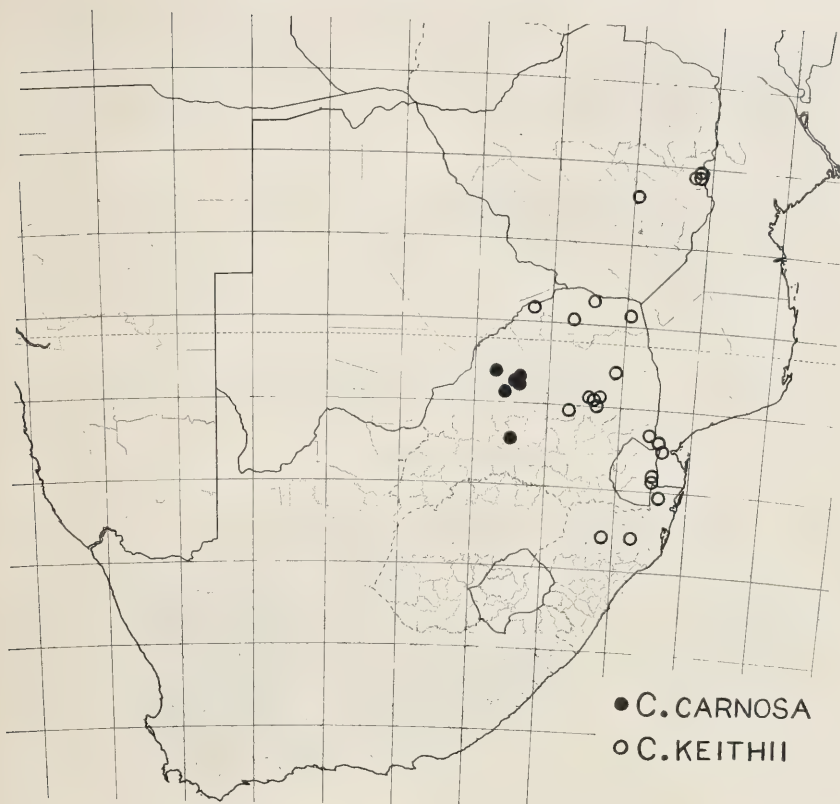
SOUTH AFRICA. Natal, Nqutu Distr.: Nqutu, Gerstner 794 (BOL). Mahlabatini Distr., Mahlabatini, Gerstner 3900 (PRE); s. loc. acc. Gerstner 728 (PRE). Ingwavuma Distr., Josini Dam, Strey 4627 (PRE). Transvaal, Barberton Distr., Lebombo Mtns., Codd 7810 (PRE); Zoutpansberg Distr., inter Waterpoort et Zoutpan, Obermeyer, Schweickerdt & Verdoorn 411 (PRE), ibid. McLoughlin s.n. (PRE), Verschuur s.n. (PRE); Punda Maria, Codd 5946 (PRE); Messina, Leach 12066 (K). Lydenburg Distr., s. loc. acc., Foster s.n., 21311 in Herb.



Photo: Botanical Research Institute, Pretoria.

***Caralluma keithii* R. A. Dyer × approx. ·8**

- A. Punda Maria, Zoutpansberg Distr., Codd 5946 (PRE).
- B. Lebombo Mtns., Barberton Distr., Codd 7810 (PRE).
- C. Near Marone, Lydenberg Distr., Codd 7720 (PRE).



Bolus. (BOL; PRE); cult. photo. Louw s.n. (NBG); Buffelsvlei, *Leach & Bayliss* 12101 (K; PRE; SRGH); Marone, *Codd* 7720 (PRE); Penge Mine, *During* s.n. 7200 in Bot. Gard. (PRE). Groblersdal Distr., Wonderboom Kuil, *Lombard* s.n. (PRE). Letaba Distr., Mica, *Braine* s.n. (NBG). Potgietersrust Distr., Limpopo Riv., *Holloway* 200 (PRE).

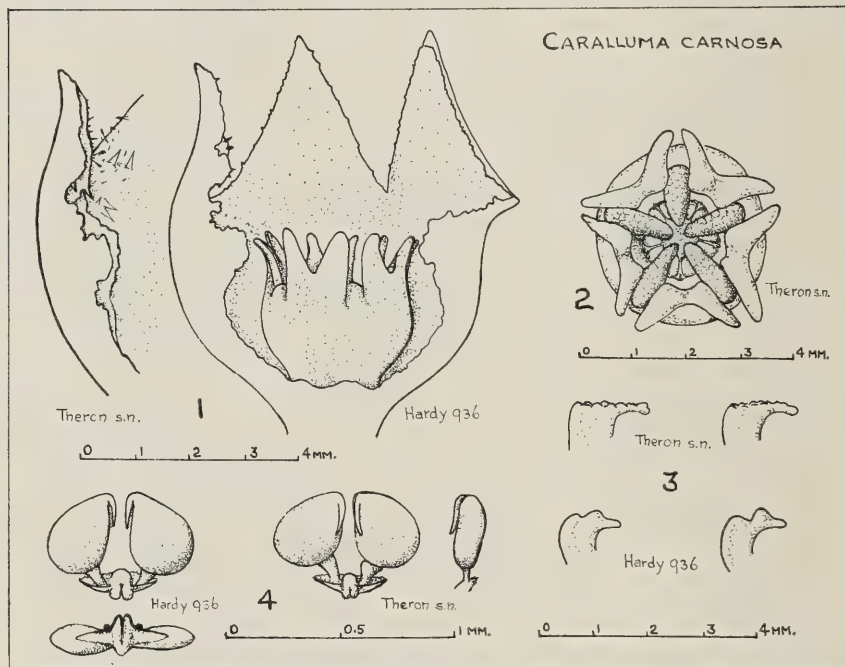
MOÇAMBIQUE. Lourenço Marques Distr.: Lebombo Mtns., *Gomes e Sousa* s.n. (PRE); Ressano Garcia, *Leach* 5525 (SRGH).

RHODESIA. Umtali Distr.: Umtali, *Chase* 4214 (BM; SRGH) *ibid.* *Leach* 9815 (PRE; SRGH), *idem.* *Leach* 10590 (SRGH); 16 mls SSW Umtali, *Plowes* 2161 (PRE), *ibid.* *Plowes* 2572 (BOL; K; PRE; SRGH); Nyahuni Riv., 25 mls SSW Umtali, *Plowes* 2574 (BOL; K; NBG; PRE; SRGH); Maranke Res., *Plowes* 2575 (K; LISC; PRE; SRGH); Odzi Riv. Maranke Res., *Plowes* 2576

(SRGH). Gutu Distr., 14 mls S. Gutu, *Leach* 10544 (SRGH).

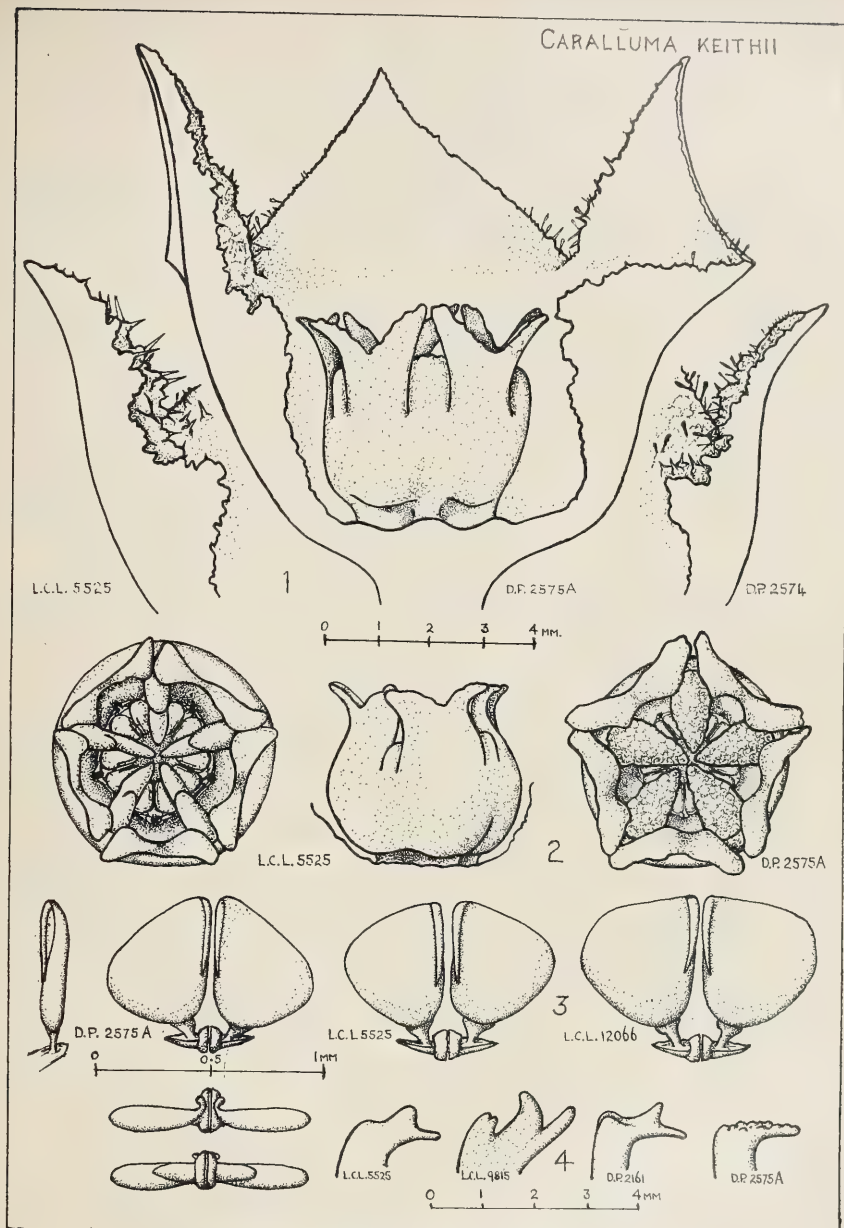
*Caralluma keithii* is extremely variable in the type and degree of hairiness of the corolla and in the shape of the inner corona lobes. The hairs vary from short to long, from acute bristles to simple, capitate or clavate hairs, and are frequently bulbous based; the ciliation also varies to a similar or perhaps even greater extent. The inner corona lobes are infinitely variable, not only between populations but also between individuals within those populations (some striking examples are given in the accompanying drawings). The outer coronas generally vary only very slightly, but one specimen from Umtali District of Rhodesia has been seen in which the corona is not at all lobed, being in this case, a crenulate margined, complete urceolate cup. In view of these wide variations it is not surprising that several synonyms exist.

Somewhat surprisingly however, there is little or no variation in coloration of the corolla which seems to be always of a rich maroon ground colour with creamy white markings which are somewhat variable in both size and shape.



*Caralluma carnosa* Stent

1, Corolla sections. 2, corona. 3, inner corona lobes. 4, pollinia.



*Caralluma keithii* R. A. Dyer

1, Corolla sections. 2, coronas. 3, pollinia. 4, inner corona lobes.



## ACKNOWLEDGEMENTS

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The Directors of the Bolus Herbarium, University of Cape Town (BOL), the Royal Botanic Gardens, Kew (K) and the National Botanic Gardens, Kirstenbosch (NBG) for the loan of valuable material, including several of the type specimens.

Mr. R. B. Drummond, Acting Chief Botanist, Government Herbarium, Salisbury (SRGH) for the facilities of the herbarium and assistance in many other directions.

# CRASSULACEAN ACID METABOLISM IN SOUTH AFRICAN SUCCULENTS:

## A PRELIMINARY INVESTIGATION INTO ITS OCCURRENCE IN VARIOUS FAMILIES

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### ABSTRACT

Thirty-five species of South African succulents belonging to twelve families were investigated for the occurrence of Crassulacean Acid Metabolism in a pilot survey. Of these only two showed high but thirteen appreciable acid formation in the dark.

### INTRODUCTION

South Africa has a particularly rich succulent flora, but as with the other striking members of our indigenous plant population, very little is known of their physiology. For many years a phenomenon termed Crassulacean Acid Metabolism has been studied in succulents, and it is characterised by an increase in the organic acid content of the chlorophyll containing tissues in the dark and a decrease in light. It is definitely associated with a conservation of carbon dioxide, which is converted into organic acid. The process is described in textbooks or in review articles as those of Ranson and Thomas (1).

Not all succulents show this Crassulacean Acid Metabolism (C.A.M.) and it is by no means clear how widely it is distributed among succulents. The succulent habit is found in many groups, so it is quite possible that a number of our major succulent families may not show this phenomenon. However, as no information was available in the literature, it was decided to investigate a few species of the major succulent families in an effort to establish the general behaviour pattern. No effort was made to undertake very accurate or reproducible work at this stage, as a general pattern was first sought. Hence techniques were reduced to the simplest possible and the results obtained were only semi-quantitative. They did give some information about the distribution of this Crassulacean Acid Metabolism in the South African flora.

### METHODS

A small number of succulent leaves (or where appropriate, some stems) were picked in the evening, or first thing in the morning and placed in a deep freezer to stop all further chemical reactions. When convenient, the leaves were rapidly cut into small pieces and placed in a homogeniser for 5—10

minutes depending on their texture, which determined the duration of this stage of the process.

If the extract was mucilaginous, it obviously could not be filtered and so was centrifuged at 1,700 G for 5 minutes. The supernatant liquid was collected and the precipitate was again well shaken up with distilled water and centrifuged. This was done four times. The supernatant liquids contained the acids.

If the homogenised solution was clear, then it was simply filtered, care being taken to see that the residue was properly washed.

In both cases the residues were carefully removed and dried in the oven to give the "dry weight" of the tissue. This dry weight was a convenient figure but it does not represent the "total dry weight" of the tissue as a water extract has been made and water soluble components including acids removed.

The filtrate was made up to a known volume, poured into a white evaporating dish to facilitate detection of colour changes. 1% phenolphthalein in 70% ethanol was used as an indicator. 0.01 N NaOH was titrated into this solution. The acid present was determined in milli-equivalents of acid. As the "dry weight" was known it was simple and meaningful to express changes in acid concentration as percentages of the daytime concentration.

## RESULTS

Each species was sampled at least three times and the results averaged. In general this gives a reasonable insight into the C.A.M. status but in some cases, such as *Senecio cephalophorus*, very inconsistent results were obtained ranging from +761% to -65%. This was unusual. One plant *Lampranthus blandus* gave quite clear cut acid fixation in some samples and in other samples showed just as definite a loss of acid. This inconsistency, as some others which undoubtedly deserve further study, was not investigated any further.

As the investigations were undertaken upon material growing in winter (w) when conditions were cold and in spring (s) when they were much warmer, no real comparison can be made. However, it was possible to determine if the plants showed signs of C.A.M., and whether this was reasonably pronounced. The following symbols were allocated in Table 1:

- + up to 30% increase in the total acids during the dark
- ++ up to 30—60% increase in the total acids during the dark
- +++ Plus over 60% increase in the total acids during the dark
- decrease of up to 30% increase in the total acids during the dark.

In fact only +++ plants need be regarded as showing significant C.A.M. and of these only one of the plants investigated, *Kleinia tomentosa*, shows a really high level of acid formation at 3421%. The next highest level of C.A.M. observed was in *Conophytum flavum* with 523%. Very few of the others exceed 100%.

## CONCLUSIONS

Table 1 gives the results in tabular form. It is clear that many of the South African succulents show some degree of C.A.M but on the basis of this survey only a few show very high levels of acid formation. However, as these investigations were done out of doors in winter (w) and spring (s) it must be clear that conditions were not ideal for acid synthesis and all species with +++ must be regarded as plants with a high potential acid formation. *Kleinia tomentosa* and *Conophytum flavum* both show high levels of acid. Many of the species

TABLE 1  
Crassulacean Acid Metabolism Rating of Some South African Succulents

Family	Species	C.A.M. Rating	Season
<i>Aizoaceae</i>	<i>Carpobrotus edulis</i> L. (N.E.Br.)	—	S
	<i>Conophytum flavum</i> N. E. Br.	+++	S
	<i>Dorotheanthus bellidiformis</i> (Burm.) N. E. Br.	—	W
	<i>Lampranthus blandus</i> (Haw.) Schwantes	inconclusive	
	<i>Lithops salicola</i> L. Bol.	+++	S
	<i>Mesembryanthemum</i> sp.	++	W
	<i>Tetragonia fruticosa</i> L.	+++	W
	<i>Trichodiadema barbatum</i> Schwantes	+++	S
<i>Asclepiadaceae</i>	<i>Ceropegia stapeliaeformis</i> Harv.	—	S
	<i>Fockea crispa</i> K. Schum.	—	W
	<i>Stapelia gigantea</i> N. E. Br.	—	S
<i>Chenopodiaceae</i>	<i>Salicornia meyeriana</i> Moss.	+	W
<i>Commelinaceae</i>	<i>Cyanotis nodiflora</i> Kunth.	+	S
<i>Compositae</i>	<i>Othonna barkeri</i> Compton	+	W
	<i>Senecio cephalophorus</i> (Compton) Jacobs.	+++	S
	<i>Kleinia tomentosa</i> Haw.	+++	S
	<i>Cotyledon</i> sp.	+++	S
	<i>Cotyledon ladysmithiensis</i> v. Poelln.	+++	S
	<i>Crassula macowaniana</i> Schoenl. & Bak. f.	+++	S
	<i>Rochea coccinea</i> (L.) D.C.	+	W
	<i>Euphorbia ingens</i> E. Mey	—	S
	<i>Pelargonium crithmifolium</i> Smith	+++	S
	<i>P. fulgidum</i> Willd.	+	W
<i>Euphorbiaceae</i>	<i>Sarcocaulon patersonii</i> DC.	+	W
<i>Liliaceae</i>	<i>Aloe excelsa</i> Berger	+	W
	<i>Astroloba rugosa</i> Roberts MS		
	(= <i>A. aspera</i> Vitew)	++	S
	<i>Gasteria excelsa</i> Bak.	+++	W
	<i>Haworthia zantneriana</i> v. Poelln.	+++	S
<i>Loranthaceae</i>	<i>Poellnitzia rubriflora</i> Vitew.	++	W
	<i>Viscum</i> sp.	++	W
<i>Portulacaceae</i>	<i>Anacampseros papyracea</i> E. Mey.	—	S
	<i>Portulacaria afra</i> Jacq.	++	W
<i>Santalaceae</i>	<i>Thesidium fragile</i> Sond.	+	S
<i>Vitaceae</i>	<i>Cissus hypoleuca</i> Harv.	+++	S
	<i>C. quadrangularis</i> L.	—	S

Details in text



investigated only showed a moderate C.A.M. So far only the Asclepiadaceae appear to show no C.A.M. The data on the Euphorbiaceae is too scanty for comment.

The general picture of these conclusions is very similar to earlier unpublished work in these laboratories on Cape succulents which showed that many of the local species had a fairly weak but readily determinable C.A.M. Those with pronounced acid forming abilities in the field appear to be rare.

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# CYTOLOGICAL OBSERVATIONS ON HYPOXIS:

## II. POLLEN GERMINATION, POLLEN TUBE GROWTH AND HAPLOID CHROMOSOME NUMBERS IN SOME *HYPOXIS* SPECIES

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### ABSTRACT

Different methods were tried for pollen germination and metaphase was arrested in some *Hypoxis* species. *Hypoxis filiformis* has 7 chromosomes in the nuclei of the pollen tubes, and the same number was recorded in an unidentified species. In *H. rooperi* there is great variation in chromosome number in different pollen tubes (43 to 58) and *H. acuminata* ( $n = 18$ ) shows some pollen tubes with 20 chromosomes.

Polyploidy has played an important role in the phylogeny of *Hypoxis* species and the chromosome number is often so high (over 80) that analysis of root tip preparations is almost impossible. In order to determine chromosome numbers it was decided to study the cell division of the generative nucleus in pollen tubes. For this reason pollen germination experiments were done, and it was combined with metaphase arrest to achieve greater separation of the chromosomes.

In a previous paper (Wilsenach, J. S. A. B., 33,1) abnormal meiosis was reported in the polyploid *Hypoxis* species, which led to the assumption that the pollen grains of such plants vary in chromosome number. This assumption can also be tested by studying the chromosome numbers in different pollen tubes of one plant.

TABLE 1

Sucrose concentration	Maximum tube length after 2 hours	Maximum tube length after 15 hours
2½%	0	—
4	0	—
5	70 $\mu$	—
8	60	—
12	110	—
15	220	240 $\mu$
20	200	—

## METHODS AND RESULTS

The pollen used was that of *Hypoxis rooperi*.

A. *The pollen germination method of Necomer (1938).*

A sugar-agar medium is used, giving the following results (incubation at room temperature).

From these results 15% sucrose was selected as the optimum concentration, but in subsequent experiments very little tube growth occurred after the first two hours.

B. *The method of La Cour and Faberge (1943).*

The pollen grains are grown on small squares of water permeable cellophane which is placed over a drop of sugar solution. These cellophane squares can be used for subsequent fixation and staining because the pollen tubes adhere quite firmly to them.

Four sugar concentrations were tried and the optimum sugar concentration was also combined with the addition of boric acid (200 p.p.m.). The results can be seen in the following table.

TABLE 2

Sucrose %	2 hours Sucrose only	2 hours + 200 p.p.m. boric acid	3 hours + 200 p.p.m. boric acid	12 hours Sucrose only
7	60 $\mu$	—	—	—
10	125 $\mu$	—	—	—
12	125 $\mu$	—	—	—
15	260 $\mu$	310 $\mu$	510 $\mu$	500 $\mu$

From the above table one can see that 15% sucrose again gave best pollen tube growth. After two hours the growth was slightly better than when the tubes are grown in sugar-agar medium, but subsequent pollen tube growth was much more successful on cellophane (500 $\mu$  after 12 hours on cellophane compared with 240 $\mu$  after 15 hours in sugar-agar medium).

This method thus proved to be better than the other (and also more convenient), and all subsequent work was done by germinating the pollen in 15% sucrose on cellophane paper, adding 200 p.p.m. boric acid.

C. *Staining and fixation.*

Fixation was done in Carnoy's Fluid for 15 minutes, and this was followed by orcein staining or by the Feulgen technique, staining for 4 hours in leucobasic Fuchsin to the recipe of Kaston and Burton (1959) and hydrolysing at 60°C for 7 minutes in 1 N HCl.

*Colchicine and acenaphthene treatment.*

The generative nucleus divides in the tube after 5 hours, but the chromosomes were grouped so closely together that metaphase analysis was practically impossible. It was therefore necessary to destroy the spindle in order to obtain greater spreading of chromosomes. For this reason 0.1%, 0.01%, 0.005% and 0.001% colchicine was used in the growing medium of 15% sucrose.

The best results were obtained in 0.005% colchicine, for which the following general observations were made: After six hours the chromosomes become denser but they are still grouped together (Fig. 1). Maximum spreading occurs after 11–18 hours (Fig. 2) and after 22 hours the chromosomes begin to despiralize and apparently form a restitution nucleus (Fig. 3).

The acenaphthene treatment did not give good results. The pollen was grown on sucrose-boric acid medium as described, and were kept in a closed petri dish in which 0.1 gm of acenaphthene was scattered. After 6 hours most of the nuclei were still in the pollen grains and the few nuclei which entered some tubes were still in prophase. This treatment resulted in inhibition, and was not continued.

RESULTS

1. *Hypoxis filiformis*,  $n = 7$ . The tip of the pollen tube often became swollen (Fig. 4a) but the chromosomes could often be observed very clearly (Figs. 4b and 4c), and the haploid number of 7 could be determined in these pollen tubes.

In Fig. 4d, the chromosome number is apparently 10, but here it is obvious that the four chromosomes to the left are double structures and that the six chromosomes to the right represent three chromosomes which of course were also double and in which the chromatids separated to form the six chromosomes observed. In the figure the dotted lines indicate the pairs which originally represented three chromosomes. This can be expected after prolonged colchicine treatment and must be considered a serious hazard when such determinations are made of high chromosome-number plants.

2. *Hypoxis* sp. (probably a form of *H. rooperi*),  $n = 43-58$ . Figs. 5a and 5b. From the discussion above it must be realised that counts of these high chromosome-number plants cannot be absolutely reliable. Counts varied between 43 and 58, and although it is agreed that these counts may to some extent be unreliable it is obvious that different generative nuclei from different pollen grains of one plant vary in chromosome number.

3. *Hypoxis acuminata*,  $n = 18$  (20). Nine determinations could be made and in seven cases the number was 18 (e.g. Fig. 6a and 6b), but in two tubes the



number was 20, although every care was taken not to consider two separated chromatids as representing two separate chromosomes (Fig. 6c).

4. *Hypoxis* sp.  $n + 7$ . This plant could not be identified but the result is presented here because it duplicates the number which was also obtained for *H. filiformis*.

#### DISCUSSION

When these results are combined with the data presented in the previous paper, the following summary can be made:-

	Root tips	Generative nuclei in pollen grains
<i>Hypoxis stellipilis</i>	$2n = 16$	
„ <i>zeyheri</i>	$2n = 32$	
„ <i>multiceps</i>	$2n = 36$	
„ <i>longifolia</i>	$2n = 72$	
„ <i>rooperi</i>	$2n = 96$	$n = \pm 43-58$
„ <i>acuminata</i>		$n = 18 (20)$
„ sp.		$n = 7$
„ <i>filiformis</i>		$n = 7$

The lowest chromosome number recorded is  $n = 7$ , but this cannot be accepted as the basic number of the genus without further study. There is definitely not a simple series of polyploidy in this genus.

The low chromosome number species (*H. filiformis*, *H. stellipilis* and *H. species*) are all relatively small plants compared with the much larger *H. longifolia* and *H. rooperi*, which have much higher chromosome numbers.

The meiosis of the 7 chromosome species is apparently quite normal (the number 7 is constantly present in all the pollen tubes) but the abnormal meiosis of the high chromosome species as described in the previous paper is confirmed here by the variation in chromosome number in the generative cell, and this apparently is also the case in species with haploid numbers as low as 18 (e.g. *H. acuminata*).

It seems very unlikely that such variation in pollen tubes and such abnormal meiosis would occur in populations which are reproducing sexually unless hybridization is taking place frequently or unless the plants are apomictic (which may of course involve a pre-history of hybridization). The morphological polymorphism of the bigger "species", their high ploidy and abnormal meiosis point to the likelihood that these plants are apomictic (see e.g. Stebbins, 1951). The smaller *Hypoxis* species on the other hand show much less morphological variation, the species seem much better defined and the meiosis is apparently

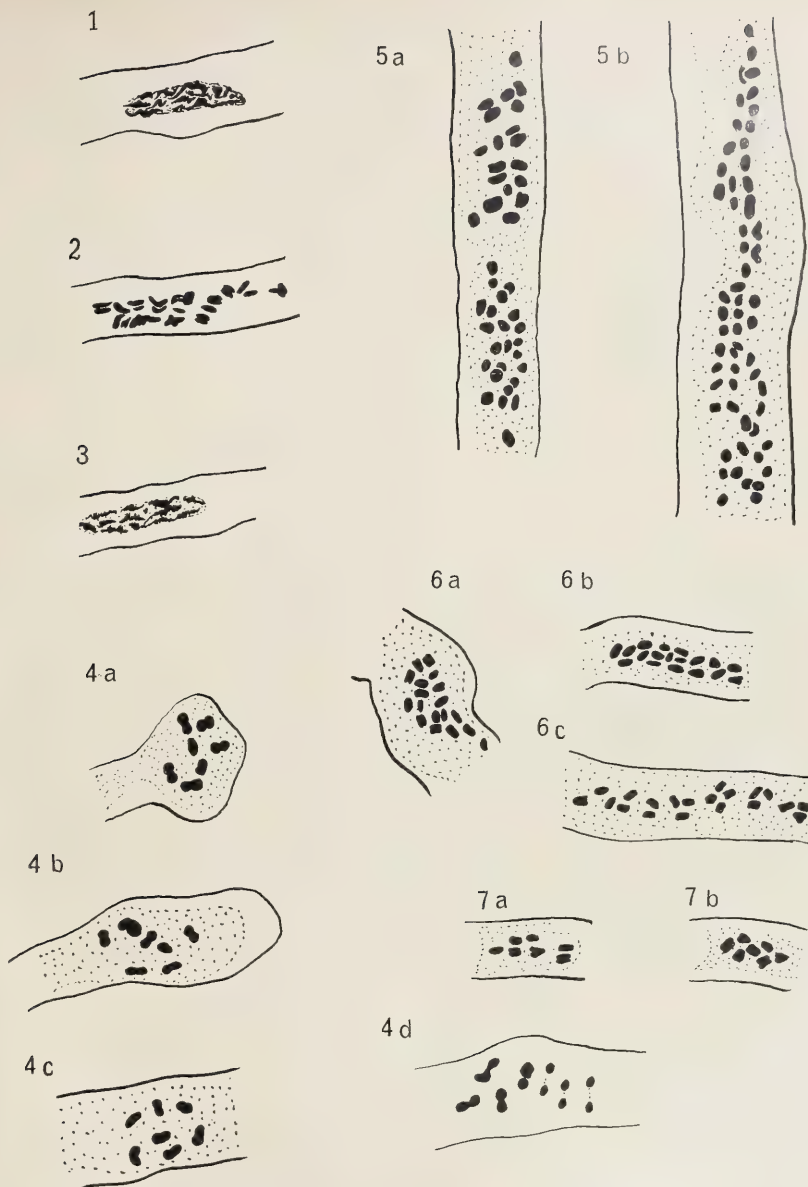


FIG. 1. *Hypoxis rooperi*. Pollen tubes grown in 15% sucrose with 0.005% colchicine. Nucleus in prophase after six hours. FIG. 2. Same after 11-18 hours. Some spreading occurs, but not sufficient for an accurate determination of chromosome number. FIG. 3. Same after 22 hours. A restitution nucleus is produced. FIG. 4. *Hypoxis filiformis*: n = 7 in Figs. a, b and c. In Fig. 4d the chromatids of three chromosomes have separated (indicated by dotted line). FIG. 5. *Hypoxis* species (similar to *H. rooperii*). n = 42 (a), n = 58 (b). FIG. 6. *Hypoxis acuminata*: a and b, n = 18; c, n = 20. FIG. 7. a and b, *Hypoxis* species, n = 7.

normal. From these data one can make the suggestion that they are reproducing sexually. These assumptions are tested in the next paper.

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# HEURNIUS AND HERMANN, THE EARLIEST KNOWN PLANT COLLECTORS AT THE CAPE:

MIA C. KARSTEN

## II. PAUL HERMANN

In 1672, nearly fifty years after HEURNIUS' visit, PAUL HERMANN or HERMANNUS, who was later to become a professor of botany at Leyden University and one of the greatest botanists of his century, followed in HEURNIUS' footsteps by collecting plants on the Cape Peninsula.

One of the best biographies of HERMANN, in which he is paid full tribute for his outstanding achievements as a botanist, we owe to LINNAEUS, who published an extensive biographical account, containing an enumeration of Cape plants, in his *Flora Zeylanica*,<sup>20</sup> which is partly quoted here.

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<sup>20</sup> LINNAEUS, *Flora Zeylanica* (1747), pp. 11-16. Original Latin text: "Hermannus (Paulus) nascitur Halae saxonum 1640. d. 30 Junii in augmentum Rei Herbariae. Plantarum amor in tenello cum lacte ita accenditur, ut puer decennis plantas lecturus in aquis incidens paene suffocatus fuisset, nisi Fata eum ad majores transfretandus aquas destinassent. Vitae genus selecturo Disciplina Medica, ob auctam cum amabili Botanica affinitatem, sese prae aliis commendat; ob hanc nocturna diurna manu cultam *Honores Doctorales* Paduae 1670 reportat.

"*Epocha Botanices* felicissima existeret circa annum 1671 cum in Europa magno numero Botanici doctissimi, curiosissimi, et laborissimi uno eodemque tempore florebant; Ex his fuere Mentzelius 65, . . . Muntingius 50, . . . Rudbeckius 47, . . . Breynius 40, . . . Seyenus 37, . . . Tournefortius 21. Qui Viri! quanta nomina! Hi conjunctis viribus infinitaque diligentia plures detegebant rariores & indicas, quam omnes ante eos vixerunt Botanici . . . Ducitur itaque mox a Syeno Hermannus ad *Bentingium*, Florae Senatorum, Virum honoribus & dignitatibus spectabilem, qui Hermannum Commendabat apud Gubernatores Societatis Indiae orientalis per Zeylonam praeficerent, spe non frustranea ductus, fore si ad Zeylonam perveniret, tantus Botanicus, grata ipsius mens quotannis selecta semina, radices, bulbos, plantas ad benefactores remittet; nec spes fefellit. Hermannus mox denominatur *Medicus* ordinarius & primarius per Zeylonam.

"Postquam fata sic vela panderant, navem conscendit Hermannus. In transitu vero, in ultimum Africae *Caput b. Spei* ascendit; hanc terram nullus Botanicorum unquam antea calcaverat. O bone Deus quam multae, quam rae & quam mirabiles plantae, uno eodemque die, se Hermanni oculis offerunt. Paucis diebus solus & unicus Hermannus hic plures detegit novas plantas Africanas, quam Botanici omnes, qui unquam in mundo ante eum extiterent. Montes rupesque tegebantur succulentis *Mesembryanthemis*, *Aloe*, *Stapeliis*, *Kleiniiis*, *Crassulis*, *Bulbinis*, *Anacampserotibus*, *Tetragonis*, *Aizois*. Nemora a *Proteis* & *Leucadendris* argento auroque nitebant. Campe vestiebantur *Borboniis*, *Penaeis*, *Blaeriis* & *Ericis* infinite ludentibus. Viae opertae erant mellifluis *Melianthis*. Sylvas & Dumeta con-

HERMANN was born at Halle in Saxony on June 30, 1646—not 1640, as stated by LINNAEUS and other authors—"to the benefit of Botany. A love of plants was aroused in the child from a very early age. But [one day] as a boy of only ten years old he set out to collect plants, and fell in the water and would have been drowned, had not the Fates destined him to traverse much greater waters. When he was about to decide on a career, the Science of Medicine, because of its close affinity to his beloved Botany, appealed to him more than any other, and having pursued this Science by day and night, he obtained his degree as a doctor of medicine at Padua in 1670.

"The year 1671 was a most productive period for Botany, since in Europe there flourished in great numbers at one and the same time many highly learned, interested and industrious botanists. Among these were Mentzel,<sup>21</sup> Munting,<sup>22</sup>

stituebant *Sideroxylo*, *Royenae*, *Hermanniae*, *Halleriae*, *Maurocenae*, *Grewiae*, *Clutiae*, *Cliffortiae*, *Brunniae* [*Bruniae*], *Galeniae*, *Brabeja*, *Myrsines*, *Philycae* [*Phylicae*], *Celastris*, *Passerinae*, *Trachonanthe*, *Baccharides*, *Eriocephali*, *Parthenia*, *Anthosperma*, *Myricae*, *Kiggelariae*. Prata vero vestiebant *Lobeliae*, *Ixiae*, *Corymbia*, *Arctopi*, *Roelliae*, *Zygophyllae*, *Gethyllides*, *Selagines*, *Hebenstretiae* [*Hebenstreitiae*], *Stoebes*, *Gerberiae* [*Gerberae*], *Haemanthi* & *Gerania* miro modo diversa. Inde misit Hermannus in Florae castra plures novas plantas quam antea illis, quibus adhuc superbiunt Horti Europaei. Hinc famam sempiternam sibi comparavit summus Inventor . . .

"Sic collecto Herbario Zeylanico perfectissimo, compingi curat plantas Zeylanicas in *Tria* volumina: in *Quarto* vero Africanas & rariores Zeylanicas miscet; . . .

"Cum jam merita & laudes Hermanni in tota Europa omnium Curiosorum ore extollerentur, moritur 1678 *Arnoldus Syenus*, Professor Botanices Leydensis. Non erat in orbe alter meritis & inventis Botanices Hermannio par, ideoque a Curatoribus Academiae mox creatur Hermannus Medicinae & Botanices Professor *Lugduno-Batavi*. Cum vero biennii fere spatio opus esset Hermannio antequam redire & officio fungi posset, constituerunt Curatores 1679 *Petrus Hottonem* Professorem Botanices usque tantum in id tempus, quo noster ex India redux se sisteret Lugduni, quod feliciter 1680, mense Augusti contigit. Adgreditur mox oblatum munus; Horti *pomeria* producit; plantas duplo plures in hortum introducit quam omnes ejus predecessores . . . ; *Museum* a se ipso collectum in horto instruit; sub feriis nunc Galliam, nunc Britanniam, nunc Germaniam plantarum causa adit. Parisiis in Horto Regio Salientes fontes, ad accessum *Principis Botanicorum* scaturiunt jubente Tournefortio. Orbis litteratus desideratissimas diu Plantas Zeylanicas sibi pollicetur, sed Lectiones publicae & privatae, negotia Academica, Consultationes studiosorum, & Horti cura horas surripuit, usque diem fatalis *Peripneumonia* Clarissimum Hermannum suffocavit die 28. Januarii 1695".

<sup>21</sup> CHRISTIAN MENTZEL (1622–1701), born at Fürstenwalde (Germany) and died in Berlin, was counsellor and physician to the Elector of Brandenburg. He took an interest in botany and became the author of the following works: *Centuria plantarum circa nobile Gedanum sponte nascentium* (Dantisci, 1650). *Index nominum plantarum universalis multilinguis, Latinarum, Graecorum et Germanorum* . . . (1682). A re-impression of the latter work entitled *Lexicon plantarum polyglotton universale* . . . (Berlin, 1696).

<sup>22</sup> ABRAHAM MUNTING or MUNTINGIUS (1626–1683), a physician and botanist of Groningen (Holland), was director of the "Hortus Botanicus Groninganus" from 1658–1683. He is the author of three botanical works, of which his publication on Aloes may be mentioned here. It is entitled *Aloidarium, sive Aloes mucronato folio americanae majoris*. Aliarumque ejusdem speciei *Historia* (Amsterdam, 1680): in this work he is styled "Medicinae Doctore, atque in Patria Academia Groninga & Omlandia Botanices Professore".



Rudbeck,<sup>23</sup> Breyné,<sup>24</sup> Syen,<sup>25</sup> Tournefort<sup>26</sup>. What men! What great names! These men, with combined forces and boundless care discovered more rarities, including Indian plants, than all the botanists who had lived before them. Hermann was soon introduced by Syen to Benting,<sup>27</sup> a "Senator" of Flora, a man notable for his honours and distinctions, who subsequently recommended him to the Governors of the East India Company for appointment as a medical doctor for the whole of Ceylon, led by the not improbable hope that if such a botanist went to Ceylon, he might well show his gratitude by sending from time to time selected seeds, roots, bulbs and plants to his benefactors. This expectation was duly fulfilled. Hermann was soon appointed ordinary and chief medical officer for the whole of Ceylon.

"After the Fates had thus unfurled the sails, Hermann embarked [in 1672]. During the voyage he disembarked on the extreme tip of Africa, the *Cape of*

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<sup>23</sup> OLAF RUDBECK (1630–1702), a Swede, was professor of medicine and anatomy at Uppsala from 1658–1693, when he resigned his professorship and was succeeded by his son Olaf Rudbeck the younger. He also showed an interest in botany: he has left a botanical work in two volumes, of which vol. II appeared first, viz. *Campi Elysii liber secundus* (qui Iridum, Narcissorum, Hyacinthorum, Tuliparum, Liliorum, Crocorum, atque alias ex bulborum genere figuras justa magnitudine expressas habet) opera Olai Rudbeck patris et filii editus (1701). Vol. I was published in 1702: *Campi Elysii liber primus* . . . Cyperacearum, Graminum et Juncacearum. Copies of the second and the printing and production of the first volume together with thousands of woodcuts were destroyed when Uppsala was devastated by a fire in May 1702. A few copies of the second volume came from the press before the fire and having been sent abroad were preserved.

His name is commemorated in the N. American genus *Rudbeckia*, L. (Compositae).

<sup>24</sup> JAKOB BREYNÉ or BREYNIUS (1637–1697), a wealthy merchant of Dantz (Gedani), Germany, was known for his interest in natural history. He is the author of a few botanical works of which *Jacobi Breynii Gedanensis Exoticarum aliarumque minus cognitarum Plantarum Centuria prima* (Gedani, 1678) is the most outstanding. It gives descriptions of no less than 48 well-marked Cape plants.

<sup>25</sup> ARNOLD SYEN was born at Amsterdam in 1640. He studied medicine at Leyden University, where he obtained his M.D. in 1659. He took up medical practice at the town of Gouda, where he established his botanical garden. On February 8, 1670, he was called to the chair of medicine at Leyden University, and was offered the position of Praefectus Horti on a salary of 1,000 guilders a year, of which he would obtain 400 guilders as an actual salary, 300 for his foreign correspondence and the rest in the form of a free house, which was supposed to be worth 300 guilders in rent. His official appointment dates from June 2, 1670. He died in 1678.

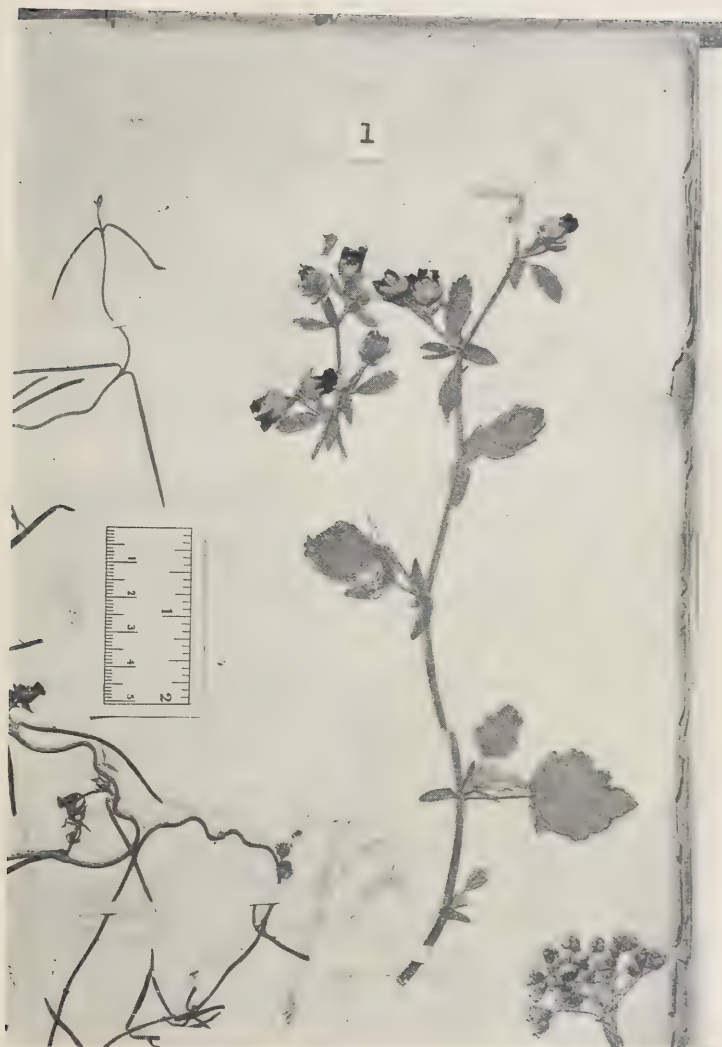
<sup>26</sup> J. PITTON DE TOURNEFORT (1656–1708), a famous French botanist. He became a professor of botany in Paris at the early age of 21. For further details see this Journal, Vol. XXIII, April, 1957, "Spartman as a Correspondent", p. 57, footnote 20.

<sup>27</sup> HANS WILLEM BARON BENTINCK or WILLIAM BENTINCK (1649–1709) entered the service of Prince WILLEM III, Stadtholder of Holland (later King WILLIAM III of England) as a page and later became his gentleman in waiting. In 1670 he accompanied the Prince on a journey to England. In 1689 BENTINCK was raised to the peerage with the titles Baron of Cirencester, "Markgraf" of Woodstock and Count of Portland. In 1696 he received the Order of the Garter. In 1698 he was appointed ambassador to France. After the death of King WILLIAM III he lived at his country seat "Zorgvliet" near The Hague, a present from the King, or on his English estates.

*Good Hope*: that land which no botanist ever before had trod. Oh Lord! How many, how rare and how wonderful were the plants that on this very day presented themselves to Hermann's eyes! In a few days Hermann alone and by himself discovered here more African plants than all botanists who ever before him had made their appearance in the world. Mountains and slopes were covered with succulents: species of *Mesembryanthemum*, *Aloe*, *Stapelia*, *Kleinia*, *Crassula*, *Bulbine*, *Anacampseros*, *Tetragonia*, *Aizoon*. *Protea* and *Leucadendron* spp. made the woodlands shine with silver and gold. Fields were covered with *Borbonia*, *Penaea*, *Blaeria* and *Erica* spp. in infinite variety. Roads were overgrown with honey-bearing *Melianthus* spp. *Sideroxylum*, *Royena*, *Hermannia*, *Halleria*, *Maurocenia*, *Grewia*, *Clutia*, *Cliffortia*, *Brunia*, *Galenia*, *Brabejum*, *Myrsine*, *Phylica*, *Celastrum*, *Passerina*, *Tarchonanthus*, *Baccharis*, *Eriocephalum*, *Parthenium*, *Anthospermum*, *Myrica*, *Kiggelaria* spp. formed woods and thickets. *Lobelia*, *Ixia*, *Corymbium*, *Arctopus*, *Roellia*, *Zygophyllum*, *Gethyllis*, *Selago*, *Hebenstreitia*, *Stoebe*, *Gerbera*, *Haemanthus*, and *Geranium* spp. in marvellous variety, clothed the open ground. From there Hermann sent to his Floral headquarters more new plants than any one before him, and to this very day the gardens of Europe are embellished by them. Thus did this eminent discoverer acquire eternal fame . . ."

LINNAEUS now proceeds to HERMANN's botanical achievements in Ceylon, at the end of which he says that HERMANN, after having collected a most perfect Herbarium of the plants of Ceylon, he had them bound in four volumes. The first three volumes are exclusively of Ceylon plants, in the fourth volume he combines African plants and the rarer ones from Ceylon.

After this LINNAEUS continues: "The merit and praises of Hermann were already sung in the whole of Europe by all interested people, when, in the year 1678, there occurred the death of Arnold Syen, Professor of Botany at Leyden. There was no other person in the world who equalled Hermann in merit and botanical discoveries, and consequently he was soon appointed by the Council of the University as Professor of Medicine and Botany at Leyden. However, Hermann needing a period of nearly two years before he could return [to Holland] to take up his post, the Council appointed Peter Hotton as Professor of Botany in 1679, until such time as our Hermann would be back from India and in a position to settle at Leyden, which fortunately took place in the month of August, 1680. He quickly took up his duties; fixed the boundaries of the University Garden, introduced twice as many plants in the garden as all his predecessors [together] . . ., revised the *Materia Medica*, established a Museum in the garden [for specimens] collected by himself. During holidays he visited France, Britain and Germany for the sake of plants. In Paris, in the Royal Botanical Garden the fountains played at the approach of the *Prince of*



Folio 1: *Hermannia triphylla*, Cav., *Microlooma tenuifolia*, K. Schum., and ?*Helichrysum*.  
Vol. 75 of the Sloane Herbarium, British Museum (Natural History), London. By permission  
of the Trustees.

*Botany*, by order of Tournefort. The educated world promised itself the plants of Ceylon which for a long time had been eagerly awaited, but public and private lectures, Academic matters, consultations with learned people, and the care of the Botanical Garden took up his time until the day that a fatal *Peripneumonia* killed the distinguished Hermann on January 28, 1695". The date of HERMANN'S passing away as given by LINNAEUS is not quite correct. He actually died on January 29, 1695, according to the record in the "Acta Senatus" of January 29, which reads<sup>28</sup>:—"The Grand Rector announced in the assembled Senate that the most distinguished Dr. Paul Herman had cast off mortality at five o'clock in the morning".

Moreover, in his *Flora Capensis*<sup>29</sup> LINNAEUS pays tribute to HERMANN in connection with his collecting at the Cape. "Hermann", quoting LINNEAUS, "was the first botanist who saw with his own eyes the plants of the Cape of Good Hope on his journey to the island of Ceylon. Here he collected about eight hundred plants, which at that time were entirely new, and of which he brought the various seeds and roots to Europe. The result was that already at that time in Holland the gardens of people interested in plants were beginning to be embellished by the wonders of nature. Of the same harvest were also those few plants, which *Th. Bartholinus*<sup>30</sup> mentions in the *Acta Hafniensia*,

<sup>28</sup> "Acta Senatus" of January 29, 1695 (Arch. Sen. Fac. 263, f. 114v-115r: "Rijksuniversiteit" (State University) at Leyden). Original Latin text: "Coacto Senatu significavit Magn. Rector, Clarissimum Virum D. Paulum Herman hora matutina quinta mortalitatem exuisse..."

<sup>29</sup> C. H. WÄNNMAN, *Flora Capensis* (1759), §4; republ. in LINNAEUS, *Amoenitates Academicae*, Vol. V, pp. 353-370 (1760): see this Journal, January, 1963, p. 29. HERMANN pp. 356-357.

Original Latin text: "Hermannus . . . primus fuit Botanicus, qui propriis oculis Capitis bonae spei plantas visitaret, sub itinere in Zeylonam insulam. Collegit hic octingentas circiter plantas, eo tempore plane novas, quarum varia semina & radices in Europam transmisit; quo factum, ut his naturae miraculis jam tum superbire inciperent horti in Hollandia curiosorum. Ejusdem messis fuere etiam paucae illae, quas *Th. Bartholinus* in *Actis Hafniensibus* Vol. II, p. 57 & 347 memorat. Non vero paucas capenses plantas Hermannus Horto Academico *Leidensi* intulit, quod satis superque constat ex hortu ejus Lugduno-Batavo, 1687 edito. Exstat praeterea egregii Hermanni brevis *Catalogus Plantarum Africanarum*, a Cl. Burmanno insertus appendici Thesauri zeylanici."

<sup>30</sup> THOMAS BARTHOLINUS (1616-1680), of Danish nationality, was professor of anatomy at Copenhagen. He studied classics at Copenhagen and travelled for 8 years through different European countries. He commenced his studies in medicine at the University at Leyden. He went to Paris, Montpellier and Padua, where he spent 3 years. He published mainly works on medicine and anatomy, but also showed an interest in botany. The *Acta Medica et Philosophica Hafniensia* (Hafnia) (=Copenhagen, 1671-79), in 4 volumes, was his last work. There is a fifth volume published by his son Caspar in 1680. In Vol. II (1673) of his work, pp. 57-58 and 347-348, he describes a number of Cape plants under the heading "Plantae Novae Africanae", with 4 plates by OLIGERUS JACOBÆUS.

The endemic Cape genus *Bartholina* (Orchidaceae) was named after him by ROBERT BROWN.



Vol. II, pp. 57 and 347. And so it was not just a few plants only which Hermann introduced from the Cape to the University Garden at Leyden (a fact which is abundantly proved by his "Hortus Lugdunus-Batavus", published in 1687). Furthermore there exists a short catalogue of African plants from the hand of the excellent Hermann, inserted by the distinguished Burmann in an Appendix in his *Thesaurus Zeylanicus*". So far LINNEAUS.

Referring to BARTHOLINUS, he actually is the author of the first publication entirely devoted to Cape plants. In Vol. II (1673) of *Acta Hafniensia*, under the heading "Plantae Novae Africanae" he writes: "In 1673, Hieremias Stolle, a surgeon, during his return journey to Copenhagen from the East Indies, while calling at the Cape of Good Hope, received from Paul Hermann, doctor of medicine (who had formerly lived at Colombo in the island of Ceylon) various plants indigenous to the Cape of Good Hope. Of these plants, which had been dried and delivered to us, we give illustrations by the skilful hand of Oligerus Jacobaeus. So far as I know these plants have not been described or figured elsewhere, and this is in order to give others the opportunity of examining them."<sup>31</sup>

Among the plants depicted and described are "Erica African. umbellata flore purpureo" (= *E. cerinthoides*, L.) "Erica African. arborescens fl. carneo" (= *E. coccinea*, Berg.), "Thymbra Africana flore purpureo" (= *Muraltia heisteria*, DC.), "Canna Africana minor fl. suaverubente" (= *Anapalina burchellii*, N. E. Br. (syn. *Gladiolus lucidor*, Baker). These and other plants had been sent by HERMANN to BARTHOLINUS in 1672.

THUNBERG, in his Preface to his *Flora Capensis*,<sup>32</sup> under the heading "Botanists and Collectors who themselves greeted this same Cape", writes about HERMANN that "he was the first Botanist to observe Cape plants diligently, and collected a noteworthy herbarium, although his stay was so short that he did not venture to wander beyond the settlement of the colonists".

ARNOLD SYEN, his predecessor, while still practising medicine at Gouda, had a celebrated and well furnished botanical garden which was visited by all connoisseurs, and because of which he stood in friendly relations with the most prominent people in the Batavian Republic, men like HIERONYMUS VAN BEVER-

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<sup>31</sup> Original Latin text: "A. 1673, ex Indiâ Orientali redux Hafniam Hieremias Stolle Chirurgus, in medio itinere, in Promontorio nempe bonae spei, à D. Paulo Hermanno Medico, qui alias in Insulae Ceilon urbe Columba habitat, accepit plantas quasdam ibidem in Capite bonae spei natas, quarum exsiccatarum nobisq; communicatarum hic icones damus, nitidâ Oligeri Jacobaei manu, quia alibi descriptas vel depictas non inveni, aliis inquirendi occasionem daturus".

<sup>32</sup> C. P. THUNBERG, *Flora Capensis* (1823 ed. Schultes). Praefatio Auctoris, p. VII.





Folio 2: *Leonotus leonurus*, R. Br. and *Anapalina burchellii*, N. E. Br.  
Vol. 75 of the Sloane Herbarium, British Museum (Natural History), London. By permission  
of the Trustees.

NINGH,<sup>33</sup> CASPAR FAGEL<sup>34</sup> and WILLEM BENTINCK, who themselves cultivated the rarest and most beautiful plants in their gardens. It was chiefly by the influence of VAN BEVERNINGH, at the instigation of SYEN (who had recommended him to H. A. VAN RHEEDE TOT DRACKENSTEIN, at the time Governor of the Dutch possessions in Malabar, as a botanist capable of investigating the flora of Ceylon), that HERMANN was charged with the task of visiting Africa, India and Ceylon at Government expense. HERMANN felt a great indebtedness to these two men, in recognition of which he sent them seeds, roots and bulbs every year. The greater part of these plants found their way to the academic gardens at Leyden which VAN BEVERNINGH took great interest in, especially after his appointment as a curator of the University in 1673. SYEN's death, five years later, was a great loss both to the University and the botanical garden.

On November 21, 1678, Curators and Burgomaster (i.e. the Leyden University Council) discussed the possibility of inviting HERMANN ("presently still employed by the East India Company in Ceylon") to succeed SYEN as professor of botany.<sup>35</sup> As a result the following letter was written to him by the Curators and Burgomaster and addressed to "Paulus Hermans op Ceylon". The letter, originally written in Latin, reads as follows<sup>36</sup>: "Although you are very far from us, and though we are separated by a great part of the world,

<sup>33</sup> HIERONYMUS VAN BEVERNINGH (1614-1690) had been a constant protector of the Leyden University Garden of which he became a trustee and curator. After a successful career as a diplomat he spent his later years at his country place "Oud-Teilingen" at Sassenheim near Leyden. At this place he established a garden in which a valuable collection of plants was grown: his keen interest in plants made him well-known as an amateur-botanist.

For the above records see H. VEENDORP and L. G. M. BAAS BECKING, *Hortus Academicus Lugduno-Batavus 1587-1937* (1937), p. 88.

<sup>34</sup> CASPAR FAGEL (1633-1688), pensionary of Holland, was a great plant-lover. His country place "Leeuwenhorst" showed a wealth of rare plants and was visited several times by the famous director of the Jardin des Plantes in Paris, J. PITTON DE TOURNEFORT. These records have been taken from VEENDORP and BAAS BECKING's work (see footnote 33), p. 88.

<sup>35</sup> "Paulus Hermans, tegenwoordigh noch sijnde in employ van de Oostindische Compagnie op Cheylon" (orig. Dutch text), was actually called to the chair of professor of botany as successor to the late Professor SYEN: "Resoluties van Curatoren", 1678, 21 November, published in P. C. MOLHUYZEN, *Bronnen tot de Geschiedenis der Leidsche Universiteit*, Vol. III (1918), p. 340.

<sup>36</sup> "Resoluties van Curatoren", published in P. C. MOLHUYZEN, *Bronnen tot de Geschiedenis der Leidsche Universiteit*, Vol. III (1918), *Bijlagen* [Supplement], the above letter, *Res.* 863, pp. 263\*-264\*.

Original Latin text: "Longissime licet a nobis sis remotus, magnoque orbis spatio separemur, fama tamen profundissimae tuae eruditionis in rebus Botanicis et cognitione plantarum non tulit se uno duntaxat loco includi, verum illa felicissimo omine ad nos non ita pridem advolavit. Quare cum immiti nuperrime fato extinctus sit praestantissimus noster Arnoldus Seyer, Botanicus dum viveret Professor, nihil nobis tanta sollicitudine cordi sit, quam ut ea provincia, qua praefatus D. Seyer aliique ipsius praedecessores tanta

yet the fame of your very deep erudition in Botanical matters and in the knowledge of plants has ensured that it should not be restricted to one place only, and that fame has by a most happy occurrence reached us not long ago.

"Therefore, as our excellent Arnold Seyen, Professor of Botany during his life, has very recently passed away by a cruel fate, we are most earnestly concerned that the post, which the aforementioned Doctor Seyen and others, his predecessors, have filled with such merit, earning them great praise from the learned, may now be filled by a worthy successor.

"Our attention has fallen on your abilities, distinguished Sir, and we have unanimously chosen you as the most suitable person to fill and honour this post.

"The salary for this post is one thousand guilders a year; further, a sufficiently spacious house will be allotted to you and your family rent free. Moreover, various emoluments go with this post, which you will very easily be able to obtain, partly out of private societies and institutions, partly out of promotions: and there are certain privileges and immunities, which Professors usually enjoy, and which add a little to the above. Perhaps these inducements are too slight to attract a man who spends his daily life amongst the luxuries of the East, but we have no such unworthy feelings as regard to your generous disposition. However, from the outstanding affection with which you embrace this study, we have formed the opinion that our hope will not be in vain. And further you will perhaps be moved by a longing for your fatherland, by which nearly all hearts, even the most steady ones, are drawn.

"And finally, if you should think yourself happier thereby, we promise you our love and goodwill in full measure and will show it.

"Farewell. Leyden. 21st November, 1678".

This is what HERMANN answered to the letter of the Curators and Burgo-master:<sup>37</sup> "I am filled with incredible joy, since I have perceived from your letter

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cum laude, tantoque doctorum elogio functi sunt, dignum demum successorem contingere possit. Incidimus in tuas dotes, Vir Clarissime, teque ut excolendae ornandaeque huic professioni maxime idoneum omnium suffragiis elegimus. Mille florenorum huic professioni est annuum stipendium; domus itidem satis spatiosa tibi tuisque gratis concedetur. Porro huic muni adhaerent varia emolumenta, quae tum ex privatis collegiis et institutionibus, tum ex promotionibus percipere facillime poteris. Privilegia quoque et immunitates, quibus frui Professores consueverunt, aliquantulum compendii prioribus adiciunt. Haec forsitan pusilla nimis sunt, quam ut hominem, inter Orientis divitias quotidie degentem, possent allicere, neque etiam tam indigne de generosa tua mente sentimus. Verum opinio, quam de insigni tuo amore, quo studium hoc amplecteris, concepimus, spem nostram irritam esse non permittit: deinde moveberis forte patriae tuae desiderio, quo fere quaelibet etiam constantissima ingenia trahuntur. Si denique et hoc te fortunatum magis putaveris, amorem nostrum et benevolentiam tibi abunde et pollicemur et praestabimus. Vale. Lugduni Batavorum 21. Novembris 1678". (Erroneously the year was given as 1679).

<sup>37</sup> "Kladnotulen Burgersdijk", in P. C. MOLHUYZEN, *Bronnen tot de Geschiedenis der Leidsche Univ.*, Vol. III (1918), *Bijlagen* [Supplement], HERMANN's letter to C. and B., pp. 267\*-268\*.

Original Latin text: "Incredibili gaudio perfusus sum, cum ex vestris literis, ipsi

to me, dated December [November!], 1678, that you not only have heard something about my name and work, but that you even think so much of my reputation, that you have not scorned generously to appoint me to the chair of Botany at the University in your town on the most favourable conditions. For this I certainly feel and express my great gratitude to you.

"I could never have thought of anything more agreeable or welcome to me than that I should serve the public interest and the honour of my fatherland according to the best of my ability.

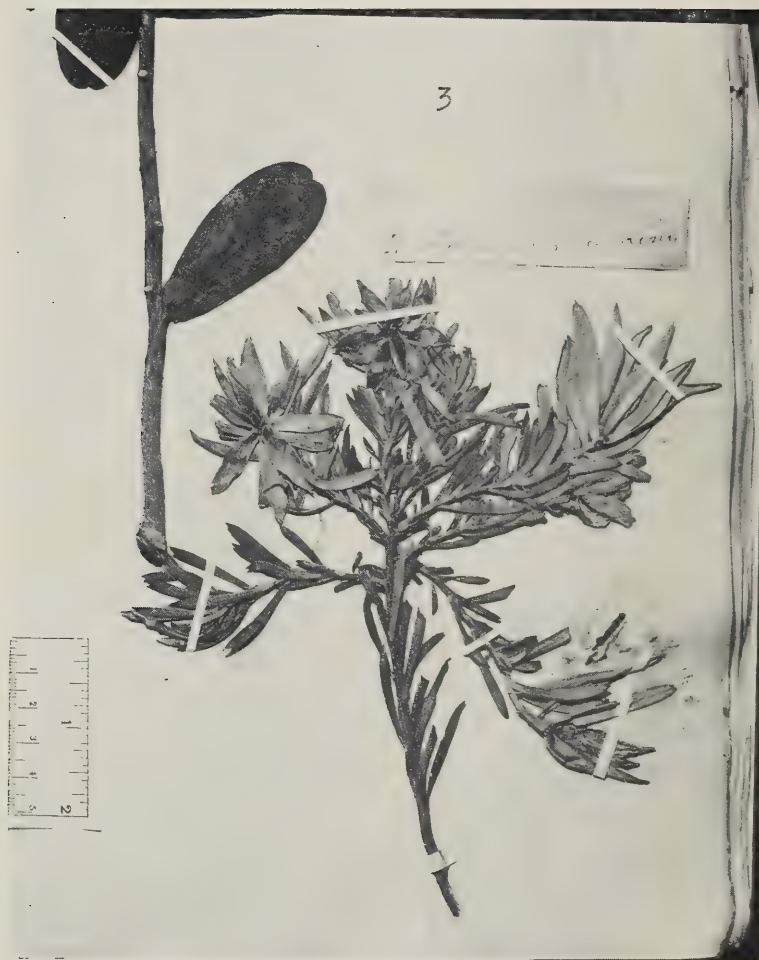
"However, realizing that this weighty commitment should be undertaken only by men of proved learning and eloquence, I confess candidly that my gifts are scarcely equal to carrying out this honourable task. Yet I will not deny that I and my studies by candlelight, when many years ago, amongst the Muses of Europe, I gave my time to the pursuit of Natural History, have not been rejected by men most highly qualified in this branch. Moreover, for an unbroken period of eight years, which I have had the privilege of spending in this island, I have devoted nearly all the time to those same studies, from which followed substantial benefit to the common good. However, far from being conceited on this account, or *Philautos* [self-satisfied], I rather seriously regret that I have missed the opportunity of cultivating at the same time the art of elegant writing, by which the arts and sciences are suitably embellished, and by which studious minds are straightway led to the true recognition of the sciences.

"Nevertheless however, since I know that I was formerly of some value in

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Kalendis Decembris Anno 1678 ad me datis intellexissem vos non solum de meo nomine et studiis inaudisse aliquid, sed et existimationi meae adeo favere, ut non designati sitis me ad professionem Botanicam Academiae vestrae urbis honestissimis conditionibus paramanter convocare. Hoc quidem nomine maximas vobis gratias et habeo et ago. Nihil enim gratius aut optatius animo meo concipere unquam potui, quam ut publicis usibus patriaeque honori pro capto industriae meae deservirem. Verum reputans mecum gravem hanc provinciam non nisi spectatae doctrinae et eloquentiae viris debere administrari, ingenue fatior meas dotes huic honorifico muneri ferendo vix esse pares. Equidem negare nequeo me measque lucubrationes, dum ante multos iam pridem annos inter Europaeas Musas rerum naturalium studio vacabam, viris etiam in hac arte exercitissimis non fuisse improbatas; porro etiam per integrum octennium, quod hac in insula degere licuit, me pene totum iisdem laboribus desudasse, ex quibus deinceps non mediocre commodum cepit commune bonum. Tamen tantum abest, ut ideo mihi sim Suffenus, aut *Philautos*, ut potius serio ingemiscam, quod mihi defuerit copia excolendi simul elegantioris literaturae genus, quo artes et scientiae perpulchre expoluntur, docilesque mentes ad veram scientiarum cognitionem recte et ordine ducuntur. Nihilominus tamen cum me olim aliquid hoc in genere valuisse sciam, et detrimentum huius cessationis cura et industria mea sarciri posse putem, insuper etiam cuilibet ingenuae indoli concessum sit vires suas cum bona spei boni publici demerendi periclitari, Dei implorato numine cepi tandem consilium proxima occasione, quae Ianuarii mense sequentis anni instabit, ad vos transfretare, vobisque, Amplissimi Viri, libenter devovere quicquid in me est doctrinae et eruditionis, non desperans fore ut omnia mea coepta et cogitata, quae ad exornandam hancce professoriam spartam ex me proficisci poterunt, vergant in Dei gloriam, vestrum honorem, totius denique Universitatis decus et emolumentum. Ita vobis et Lycaeο vestro omnia feliciter et ex voto contingant. Salvete et valet. Datum Columbi, 23. Octobr. A<sup>o</sup>. 1679.





Folio 3: *Leucadendron adscendens*, R. Br.

Vol. 75 of the Sloane Herbarium, British Museum (Natural History), London. By permission of the Trustees.



this respect, and since I think that I am able to remedy the harm of this omission by careful industry, especially also since every one is allowed to try his strength with the firm expectation of serving the public interest, I have, after praying to God, at last decided to cross the sea at the earliest opportunity, which will be in January of next year, and freely to offer you, distinguished Sirs, whatever knowledge and wisdom may be in me, in the fervent hope that all the plans and thoughts, which I may bring to adorn the professional post, may turn to the glory of God, to your honour, and finally to the dignity and advantage of the whole University.

"Thus may everything turn out happily and according to your wish for you and your Academy. Farewell. Written at Colombo, 23rd October, 1679".

HERMANN's appointment as a professor followed on August 24, 1680, shortly after his return to Holland: "At the same session, the minutes of the Curators and Consuls were read, by which they appointed the most distinguished Paul Hermans, Doctor of Medicine, to be ordinary Professor of Medicine and Botany".<sup>38</sup> It was approved at the council of Curators that HERMANN be paid for the expenses of his long voyage the sum of 250 guilders. Doctor PETER HOTTON who in May 1679 had been appointed as a temporary Professor of Botany, during the time of HERMANN's absence, was paid tribute for the most capable and diligent way he had acquitted himself of his task.

About HERMANN's work as a professor, it is stated in the Syllabus of summer lectures in the Leyden University ("Batavian Academy") in 1681 that in the morning at 8 o'clock he will lecture on Botany in the Botanic Garden of the University.<sup>39</sup> The duties of HERMANN became more onerous in 1686, when he was appointed to teach practical medicine on an extra salary of 200 guilders.

HERMANN undoubtedly was the first botanist who gathered plants at the Cape, viz. in 1672, on his outward journey to Ceylon, and formed a herbarium of the specimens collected. As already mentioned, the Cape plants were incorporated in the fourth (and last) volume of his Ceylon herbarium, and it was on this herbarium that LINNAEUS based his *Flora Zeylanica*. This work does not use the binominal nomenclature, as it had not yet been introduced at that time, but the genera are named by LINNAEUS, as far as he could. Binominals

<sup>38</sup> "Acta Senatus" 1680, Aug. 24, published in P. C. MOLHUYZEN, *Bronnen tot de Geschiedenis der Leidsche Universiteit*, Vol. III (1918), p. 352. Original Latin text: "Eadem sessione lecta sunt acta Curatorum et Consulum, quibus Clariss. Virum Paulum Hermans, Med. Doctorum, renuntiant Medicinae ac Botanices Professorem ordinarium".

<sup>39</sup> "Kladnotulen Burgersdijk", published in P. C. MOLHUYZEN, *Bronnen tot de Geschiedenis der Leidsche Univ.*, Vol. III (1918), p. 268. Original Latin text: "Ordo Lectionum Aestivarum in Academia Batava Leidensi, Anno 1681. Mane. Hora octava. D. Paulus Hermann Botanicen in Horto Academico docebit".



Folio 4: *Erica curviflora*, L.  
Vol. 75 of the Sloane Herbarium, British Museum (Natural History), London. By permission  
of the Trustees.

were added in LINNAEUS' *Species Plantarum* (1753). A great number of the plants were named by HERMANN himself, and many are type specimens. The *Musaeum Zeylanicum*, edited by WILLIAM SHERARD from HERMANN's notes in 1717, is a catalogue of this collection.

HERMANN's collections as a whole have an interesting history. His widow, ANNA GEERTRUY, née STOMPHIUS, was, according to UFFENBACH,<sup>40</sup> decidedly not a business woman and did not take proper care of her husband's valuable collections (though she is on record as having shown an interest in plants by collecting the liverwort *Pellia calycina*, Nees (Hepaticae) near Tunbridge in England.<sup>41</sup>) HERMANN's *Museum Indicum*, estimated to be worth 12,000 guilders, was in a very dilapidated condition in 1711, when UFFENBACH saw it. The herbarium alone was valued at 3,000 guilders, but after it had been very badly spoilt, it was sold, in 1711, for 300 guilders to the king of Prussia. The herbarium later on came into the hands of AUGUST GÜNTHER, Apothecary Royal at Copenhagen, who, apparently not knowing its history, in 1745 sent it to LINNAEUS, who at once identified it as HERMANN's collection. GÜNTHER, to whom LINNAEUS returned it, gave it or sold it to Count ADAM GOTTLÖB MÖLTKE, after whose death it was bought, with his library, by Professor TRESCHOW of Copenhagen, who in 1793 sold it to Sir JOSEPH BANKS<sup>42</sup> for £75. The herbarium was finally incorporated in the Sloane Herbarium, and forms now one of the most treasured possessions of the British Museum (Natural History).

As to HERMANN's Cape plants, they had found their way to England over eighty years before the purchase of the herbarium by BANKS. In June 1711, at the sale of HERMANN's herbarium (to the king of Prussia), the Cape specimens were bought by JAMES PETIVER (c. 1663–1718), a wealthy London apothecary, for Sir HANS SLOANE<sup>43</sup>. These form Vol. 75 of the Sloane Her-

<sup>40</sup> ZACHARIAS CONRAD VON UFFENBACH, in his work *Merkwürdige Reisen durch Niedersachsen, Holland und England* (Ulm, 1754) [Noteworthy Journeys through Lower Saxony, Holland and England], 3 volumes, with copper plate engravings.

<sup>41</sup> This *Pellia* specimen is in the Sloane Herbarium (H.S. 329, f. 60), labelled by PETIVER "Found abt Tunbridge by Madam Herman". It is not recorded when she visited England.

<sup>42</sup> Sir JOSEPH BANKS (1743–1820), a wealthy man, who became president of the Royal Society, undertook botanical journeys to Newfoundland and Labrador, and made his name by accompanying Capt. JAMES COOK on his voyage round the world in the "Endeavour" (1768–1771). He was a joint founder of the Linnean Society of London, of which he was the president from the year of its foundation until his death.

<sup>43</sup> Sir HANS SLOANE (1660–1753) was a famous English physician, who also made his name as a naturalist. At the age of 24 he went to Jamaica as a physician in ordinary of the Duke of ALBEMARLE. The plants he collected there are in the first 8 volumes of his herbarium and formed the basis of his *Natural History of Jamaica*. His great influence and princely means enabled him to form the most extensive botanical collection of his time. The complete collection *naturalia*, including his enormous herbarium comprising no less

barium, which is in the British Museum (Natural History). This herbarium collection, entitled "Plants gathered by Dr. Herman at the Cape of Good hope in 1672", numbers 66 folios with an average of 3 or 4 specimens on each sheet. They are good specimens, many named by SOLANDER<sup>44</sup> and some described as new in his MSS.; a few have been at some time removed. The collection corresponds with, but contains many more specimens than the one listed by BARTHOLINUS, which was given by HERMANN to HEREMIAS STOLLE as mentioned before.

Photographs of a fine selection of four of the folios with HERMANN'S Cape plants are reproduced herewith, numbered 1, 2, 3 and 4. The mounted specimens are very well preserved and could be easily identified.

Folio 1 shows *Hermannia triphylla*, Cav. (Sterculiaceae) with to the left *Microlooma tenuifolia*, K. Schum. (Asclepiadaceae), a plentiful plant of the Western Cape of a twining habit, known as "Red Wax Creeper" or "Kannetjies", showing its very narrow leaves and a couple of small flowers. The specimen at the bottom of the sheet to the right of the *Hermannia* probably is a *Helichrysum* sp. (Compositae). Mounted on folio 2 are also two species of plants, viz. *Leonotis leonurus*, R. Br. (Labiateae), the "Minaret Flower" or "Wilde Dagga", and to the right of it *Anapalina burchellii*, N. E. Br. (Iridaceae), a name which replaces the one written on the sheet, viz. *Gladiolus lucidor*. The Proteaceae are represented on folio 3 by *Leucadendron adscendens*, R. Br., a common shrub on the Cape Peninsula: a label stuck on the sheet bears the name "2. *Protea conifera*, Linn.", in a flourishing handwriting, probably SOLANDER'S. The 2-leaved branch to the left is difficult to identify. The specimen on folio 4, labelled in the same handwriting "*Erica tubiflora*, Linn.", has been identified as *E. curviflora*, L.

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than 333 large folio volumes, was acquired by the State after his death in 1753 for the amount of £20,000 and has been kept in the Natural History Department of the British Museum, South Kensington (London), since 1881. As a matter of fact the British Museum (Nat. Hist.) dates its actual foundation from the year of acquisition of SLOANE'S collections.

<sup>44</sup> DANIEL CARL SOLANDER, born at Pitea, Norrland, Sweden, in 1733, and died in London in 1782, was a favourite pupil of LINNAEUS. After having taken his doctor's degree at Uppsala, he settled in England in 1760, where he became an assistant at the British Museum in 1763. He accompanied BANKS on Capt. COOK'S first voyage round the world. In 1773 he was again attached to the staff of the British Museum, now as a curator of the Natural History Department.

(To be continued)



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CYTOLOGICAL OBSERVATIONS ON  
HYPOXIS:

III. EMBRYO-SAC DEVELOPMENT IN *HYPOXIS ROOPERII*  
AND *H. FILIFORMIS*

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ABSTRACT

Embryo-sac development was studied in *Hypoxis filiformis* ( $n = 7$ ) and *H. rooperii* ( $2n = \pm 96$ ). In both cases there is degeneration of the megaspore (or megaspore mother cell) and it looked as if the embryo-sac is produced from nucellar cells. *Hypoxis rooperii* ovules very commonly have two embryo-sacs. Suggestions were made for future research.

Data presented in the first two papers (Wilsenach, and Wilsenach & Papenfus) led to a hypothesis that at least some of the *Hypoxis* "species" are apomictic. Of the "species" studied *Hypoxis rooperii* had the most convincing apomictic features: the plants have a high somatic chromosome number (96), meiosis is abnormal, pollen grains are formed which contain a variable number of chromosomes (43 to 58) and the populations show morphological variation. This "species" has therefore been selected for a study of embryo-sac development in order to test the assumption that it is apomictic.

*Hypoxis filiformis* represents the other extreme—it has a low chromosome number ( $n = 7$ ) and this number is present in all the generative nuclei in the pollen tubes. The populations also show very little morphological variation. This "species" was selected for embryo-sac development study because it appeared to be the most likely one to have normal sexual reproduction.

METHODS

Inflorescences in various stages of development were collected from plants



growing in their natural habitat, and were fixed in Randolph's Modified Navashin Fluid as quoted by Johansen (1940). The material was dehydrated in normal butyl-ethyl alcohol mixtures, wax-embedded and the section thickness was 15 to 20 micron. The sections were stained in Fast Green and Safranin.

#### THE EMBRYO-SAC DEVELOPMENT OF *HYPOXIS FILIFORMIS*

##### (i) *The integuments and type of ovule.*

This is not shown in the diagrams, but the ovule is anatropous, and the integuments are evident from the earliest stages recorded here, e.g. in the ovule illustrated in Fig. 1A, the inner integument already covered two-thirds of the nucellus.

##### (ii) *Megasporogenesis.*

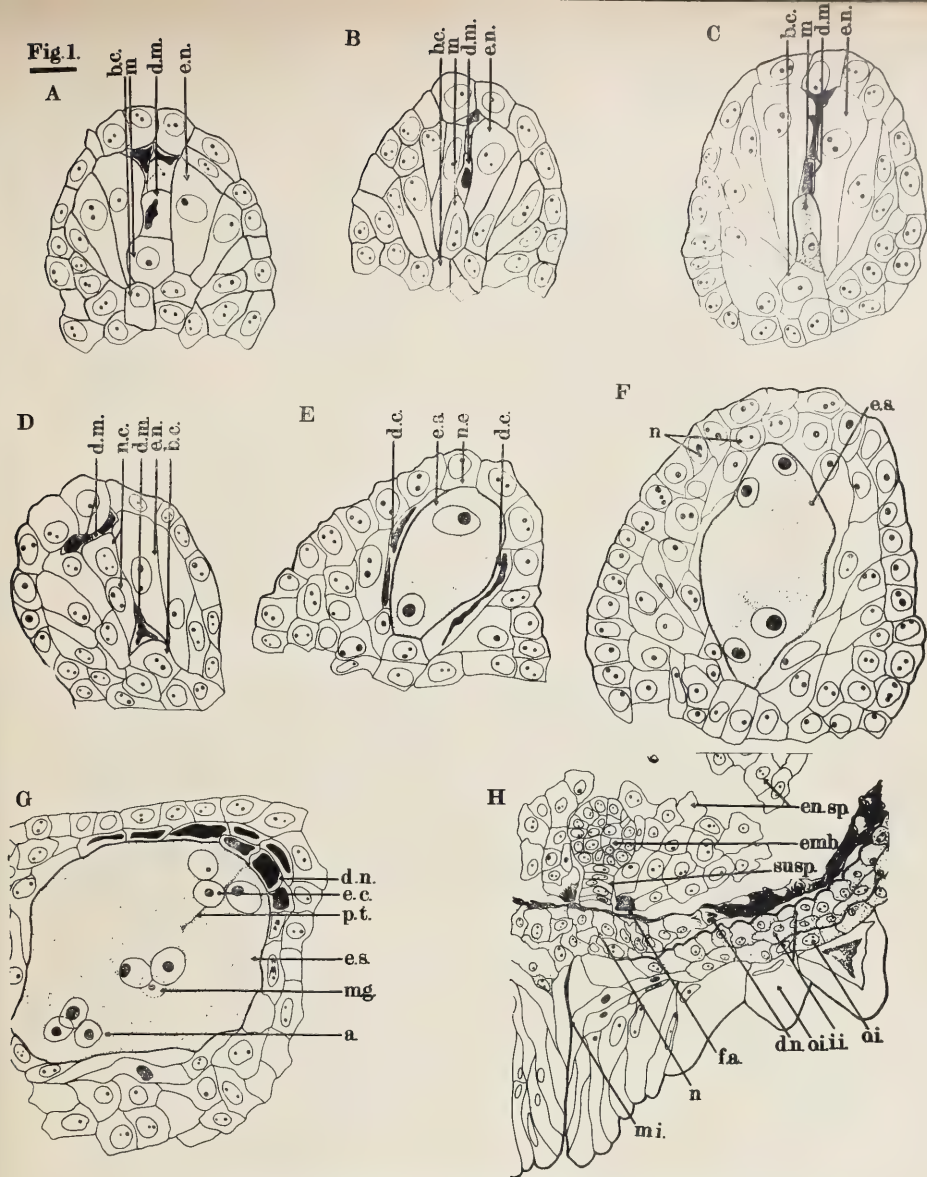
The structure of the megaspore-mother-cell (m.m.c.) was not recorded, the earliest stage recorded was the tetrad of megaspores as seen in Fig. 1A. From this it is evident that the tetrad is T-shaped, that it is surrounded by big nucellar cells, and it regularly "sits" on a basal cell (b.c.). A sub-epidermal archesporial cell obviously gives rise to the megaspores directly, since there are no cells between the tetrad and the nucellar epidermis (n.e.). In Fig. 1A one can see that a periclinal division took place in one cell of the nucellar epidermis.

##### (iii) *The fate of the megaspores.*

The three micropyle-end megaspores show signs of degeneration at a very early stage (see Figs. 1A, 1B and 1C). The fate of the fourth megaspore is not at all easy to determine. In Fig. 1C this megaspore also shows signs of degeneration, which is evident by a change of the staining (as soon as cells degenerate the cytoplasm stain red compared with the typically green cytoplasm after safranin—fast green staining). In Fig. 1D the interpretation is as follows: All four megaspores have degenerated, the two micropyle-end megaspores can be recognised by the position below the nucellar epidermis and the other two have become separated from them by the nucellar cells labelled n.c. The position of the chalazal end megaspore relative to the basal cell (b.c. in all the figures) is considered to be a helpful criterion in the identification of this cell.

##### (iv) *The origin of the embryo-sac.*

As soon as degeneration of the megaspores takes place some of the elongated nucellar cells (e.n.) begin to enlarge considerably, and this must result in distortion within the ovule. In Fig. 1E a two-nucleated embryo-sac can be seen, with degenerated cells laterally next to it, but no degenerated cells between it and the nucellar epidermis. The most plausible explanation is that some of the cells labelled "d.c." in Fig. 1E must represent the four degenerated megaspores and that this embryo-sac was produced by an enlarged nucellar cell, which will explain why no degenerated cells can be seen between it and the nucellar epidermis.

**Fig. 1.****FIG. 1. Embryo-sac development in *Hypoxis filiformis*.**

- A. Young ovule showing T-shaped tetrads, of which the three micropylar megaspores have degenerated (d.m.).  
 B. Similar ovule.  
 C. Slightly older ovule, chalazal megaspore (m.) now also showing signs of degeneration.  
 D. Ovule with all 4 megaspores in degenerated condition (d.m.).  
 E. Ovule with bi-nucleated embryo-sac, with degenerated cells laterally (d.c.). Suggested origin of embryo-sac is from an enlarged nucellar cell.  
 F. Four-nucleated embryo-sac (e.s.), nucellar epidermis double (n.) as result of periclinal divisions of original nucellar epidermis.  
 G. Eight-nucleated embryo-sac. Male gamete (m.g.) can be seen next to polar nuclei, and signs of male gamete entry can be seen (p.t.).  
 H. Ovule with embryo (emb.) suspended in endosperm (en. sp.).  
 a. antipodals; b.c. basal cell; d.m. degenerating cells; d.n. degenerating nucellar cells; e.c. egg cell; e.n. enlarging nucellar cell; e.s. embryo sac; emb. embryo; en. sp. endosperm; f.a. filiform apparatus; i.i. inner integument; m. megaspore; m.g. male gamete; m.m.c. megaspore mother cell; n. nucellus; n.e. nucellar epidermis; o.i. outer integument; p.t. signs of male gamete entry; susp. suspensor.

(v) *The four-nucleated embryo-sac* (Fig. 1F).

Two nuclei are arranged at the micropyle end, two at the other end and a big vacuole is present between them. The periclinal divisions which started earlier (see e.g. Fig. 1A) have continued, with the result that the nucellar epidermis has become two layered (labelled "n" in Fig. 1F).

(vi) *The eight-nucleated embryo-sac*.

As the embryo-sac enlarges some of the nucellus degenerates ("d.n." in Fig. 1G). The eight nuclei are arranged in the typical 3-2-3 arrangement, the nuclei are all small but no filiform apparatus can yet be seen in the synergids. A faint line, labelled "p.t." represents signs of the entry of the male gamete (m.g.) which can now be seen next to the two polar nuclei.

(vii) *The embryo, endosperm and the integuments*.

Stenar (1925) described helobial endosperm development in *Hypoxis*. Our observations are incomplete, but at an early stage two masses of cytoplasm with free nuclei can be seen—one at the micropylar end, one mass at the chalazal end. Subsequent wall formation results in a mass of cellular endosperm at the micropylar end and a disc of cellular endosperm at the chalazal end. These observations are what one would expect to find in helobial endosperm development.

The embryo lies embedded in the endosperm and is attached to a small nucellar cap by a short suspensor.

Markotter (1936) found that the seeds of related genera require a prolonged after-ripening period—it is possible that the embryo then becomes more differentiated. This will explain the failures we have met with in our efforts to germinate freshly collected seed.

The testa of the mature seed is formed by the integuments, both of which remain largely two-layered. The epidermis becomes so thickened that the lumina of the cells are practically obliterated.

*To summarise:* Megasporogenesis apparently occurs normally, it is followed by the early degeneration of the three micropyle-end megaspores, but the remaining megaspore soon also shows signs of degeneration. It is suggested that a nucellar cell then produces the embryo-sac which becomes the typical 8-nucleated structure. Pollen tube entry has been recorded, fertilization of polar nuclei apparently takes place but the embryo, it is suggested, develops from the egg cell without fertilization.

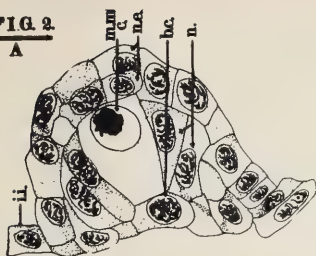
#### *HYPOXIS ROOPERII*

(i) *The megaspore-mother-cell and its fate*.

At very early stages it is easy to recognise the megaspore-mother-cell (m.m.c.) as a much enlarged cell in the nucellus. It is surrounded by large elongated

**FIG. 2**

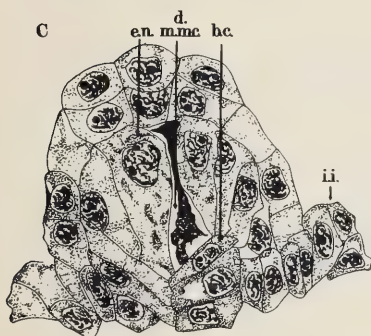
**A**



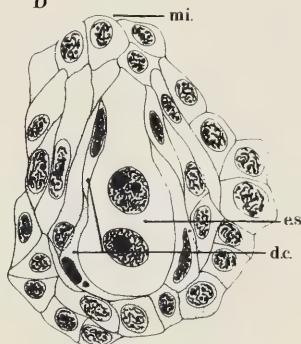
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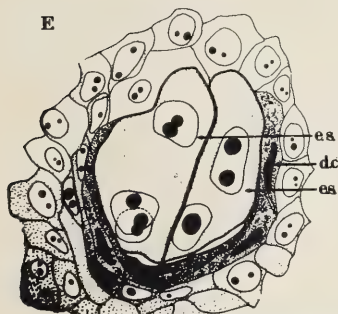
**C**



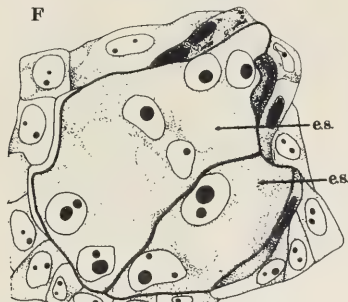
**D**



**E**



**F**



**FIG. 2. Stages in embryo-sac development in *Hypoxis rooperii*.**

- A. Young ovule with megaspore mother cell (m.m.c.), showing beginning of the inner integument (i.i.) and doubling of the nucellar epidermis (n.e.).
- B. First signs of degeneration of the m.m.c.
- C. Degenerated m.m.c., which is being squashed by an enlarging nucellar cell (e.n.).
- D. Two-nucleated embryo-sac, suggested origin is from an enlarged nucellar cell. Degenerated cell (d.c.) must represent the displaced degenerated m.m.c.
- E. Twin embryo-sacs, a very common occurrence.
- F. Later stage of two embryo-sacs, one shows 6 nuclei and the other 2.



nucellar cells, and there is a layer of cells between the m.m.c. and the nucellar epidermis (Fig. 2A).

There seems to be some variation in the immediate development of the m.m.c. In one case an anaphase of meiosis I could be observed but in most cases there was very early degeneration of the m.m.c. as is illustrated in Fig. 2c. Fig. 2b represents an earlier stage where the m.m.c. becomes pink, which is a sign of early degeneration.

The identification of the degenerated cell as the m.m.c. is possible at early stages. This explains why meiosis was observed in only one slide and why tetrads could never be seen.

As soon as the m.m.c. degenerates an adjacent nucellar cell enlarges (Figs. 2b and 2c) and encroaches upon it so that it will become displaced. In Fig. 2d such displaced degenerated cells can be seen (d.c.).

(ii) *The origin of the embryo-sac.*

The chromosome number of the cells is so high that it was impossible to determine the ploidy of the different cells, which makes interpretation of subsequent stages extremely difficult.

In Fig. 2d a two-nucleated embryo-sac can be seen, and it is interpreted as being derived from the enlarged nucellar cell. At least one of the degenerated cells should be the remains of the m.m.c.

(iii) *Twin embryo-sacs.*

Twin-embryo-sacs are subsequently seen very commonly (Figs. 2E and 2F), of which one is invariably bigger than the other. In Fig. 2F one bi-nucleated and one six-nucleated embryo-sac can be seen, in Fig. 2E one is bi-nucleated and the other one possesses at least three nuclei. The origin of the second embryo-sac could not be determined, and two interpretations are possible:

(a) They are both formed from the nucellar cells.

(b) One has an aposporic origin, the other from the megaspore.

We favour the first interpretation because the rule at early stages is degeneration of the m.m.c., whereas the rule at later stages is twin embryo-sacs; and furthermore it must be remembered that tetrads were never observed. Even if this interpretation is not correct, at least one embryo-sac must have an aposporic origin.

Similar twin embryo-sacs were also observed by Joubert (unpublished) in *Hypoxis costata*.

#### DISCUSSION

Results in the previous two papers (Wilsenach, Wilsenach & Papenfus) have indicated the probability that at least some *Hypoxis* populations are apomictic, which led to the studies which are reported in the last paper on embryo-sac



III. Embryo-sac Development in *Hypoxis rooperii* and *H. filiformis*

development. It must be realised that it is extremely difficult to demonstrate that a megaspore-mother-cell (m.m.c.) (or the megaspore) degenerates and that it is replaced by a nucellar cell, because once the cell is in a degenerated condition it is almost impossible to establish whether it represents a megaspore or a nucellar cell.

Stenar (1925) reported on embryo-sac development of two *Hypoxis* species viz. *H. decumbens* L. and *H. villosa* L. (These have since been combined, and are now considered to be synonyms). She made some observations which are confirmed in the present study e.g. the m.m.c. originates from an archesporial cell which lies below the nucellar epidermis, the megaspore tetrad is T-shaped, the nucellar epidermis divides periclinally, the ovule is anatropous and two integuments are present. Unfortunately her drawings of the embryo-sacs do not include the adjoining nucellar tissue—an aspect that would have been of great interest to us. Stenar described normal monosporic eight-nucleate embryo-sac development, but she does record the occurrence of two two-nucleated embryo-sacs per ovule as exceptions. She suggests three explanations: (a) they are formed by two embryo-sac mother cells (presumably meaning two functional megaspores); (b) they were formed because no cell wall was produced after the second meiotic division; (c) they were formed by two megaspores from one tetrad.

In the present study such double embryo-sacs occurred commonly in *H. rooperii*, and the phenomenon was accompanied by degeneration of the megaspore mother cell, so that their origin is from nucellar cells. This possibility was not mentioned by Stenar, and it is very interesting to note that she could not observe any degenerating megaspores next to the two young embryo-sacs—it could be that the m.m.c. degenerated at an early stage, or that the archesporial cell formed one of the embryo-sacs without undergoing the reduction division, the other embryo-sac being formed by a nucellar cell. Such events will very easily be overlooked unless one is on the look-out for these occurrences as a result of earlier data which strongly suggest the presence of apomixis.

It has come as a surprise to us that even *H. filiformis* ( $n = 7$ ) shows definite signs of apomixis. If this can be confirmed apomixis could quite well occur in nearly all our South African species.

Where does all this leave us?

Firstly, it must be pointed out that apomixis has not been confirmed without doubt, but everything points to this: The plants are very polymorphic, there is great variation in chromosome number, meiosis of pollen mother cells shows many abnormalities in the high chromosome number species, pollen grains possess different numbers of chromosomes in these plants, megaspores (or

megaspore mother cells) degenerate and twin embryo-sacs are common. More research is necessary to confirm the idea that these plants are apomictic and this will involve: (a) more detailed studies of embryo-sac development of different so-called "species"; (b) more studies of somatic chromosome numbers, and here some statistical treatment of populations is necessary; (c) studies of meiotic behaviour of more populations; (d) studies involving genetical experiments. These could quite easily establish apomixis, but one is confronted with the problem that the seeds need a long after-ripening period, making such experiments very time consuming. The most obvious first step is to record the variation in the offspring of open pollinated specimens.

In the meantime a revision of the genus should not be attempted and taxonomists should refrain from the temptation of describing new species. Dobzhansky (1941), Babcock and Stebbins (1938) and Stebbins (1951) have put it quite clearly: The species concept as applied to sexual organisms is not reality in agamic complexes. As Stebbins pointed out: "Disputes between systematists not fully conscious of the biological situation in these groups are particularly academic and futile." Babcock and Stebbins (1938) suggested that the clearest concept of interrelations and phylogeny of the agamic complex is obtained by drawing arbitrary species boundaries which are related to the original boundaries of the sexual species ancestral to the complex. Unfortunately we cannot even suggest the ancestral basic chromosome number, and it will involve many years of intensive study to reveal the sexual ancestors. In the meantime *Hypoxis* will remain a "headache to the systematist". What an unhappy way of ending a series of three papers!

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# SOME NEW COMBINATIONS AND THREE NEW SPECIES OF LEUCADENDRON (PROTEACEAE).

ION WILLIAMS

## ABSTRACT

In this paper several new combinations are proposed. These have been found to be necessary as a result of research into the nomenclature of the Genus. Three new species of *Leucadendron* from the Ceres Division are described:—*L. barkerae*, from the borders of the Karroo, was formerly placed with *L. venosum* R. Br. by Phillips & Hutchinson in the Flora Capensis; *L. bonum* with its silvery leaves, is a rare plant recently discovered in the Northern Cold Bokkeveld; *L. gydoense* is a species quite frequent locally at the summit of the Gydo Pass.

**1. *Leucadendron arcuatum* (Lam.) Williams comb. nov.**

*Protea arcuata* Lamarck Tabl. Bot. 234 (1791).

*Leucadendron spathulatum* R.Br. in Trans. Linn. Soc. **10**: 54 (1810).

*Protea mutica* Poir. Encyl. Bot. Supp. **4**: 555 (1816).

**2. *Leucadendron chamelaeae* (Lam.) Williams comb. nov.**

*Protea chamelaeae* Lam. Tabl. Bot. 237 (1791) excl. syn. Breyn.

*Leucadendron decurrens* R.Br. in Trans. Linn. Soc. **10**: 59 (1810).

*Protea pyramidalis* Thunb. in Hoffm. Phyt. Blatt. 11 (1803).

**3. *Leucadendron conicum* (Lam.) Williams comb. nov.**

*Protea conica* Lam. Tabl. Bot. 237 (1791).

*Leucadendron ramosissimum* Buek ex Meisn. in D.C. Prodr. **14**: 221 (1856).

**4. *Leucadendron crassulaefolium* (Salisb. ex Knight) Williams comb. nov.**

*Protea crassulaefolia* Salisb. ex Knight Prot. 28 (1809).

*Leucadendron crassifolium* R.Br. in Trans. Linn. Soc. **10**: 66 (1810).

**5. *Leucadendron globosum* (Andr.) Williams comb. nov.**

*Protea globosa* Andrews Bot. Rep. 307 (1803).

*Euryspermum concolor* Salisb. ex Knight Prot. 24 (1809).

*Leucadendron ovale* R.Br. in Trans. Linn. Soc. **10**: 59 (1810).

*Note:* It is possible that a more correct citation would be *L. globosum* (Kennedy ex Andrews) Williams comb. nov. if we are to believe Salisbury in Knight Prot. 25 (1809) who under *Euryspermum concolor* cites "*Protea globosa*

Kenn. in Bot. Rep. 307". See also the footnote in the Journal of Botany **24**: 296 (1886).

**6. *Leucadendron longicaule*** (Salisb. ex Knight) Williams comb. nov.

*Protea longicaulis* Salisb. ex Knight Prot. 29 (1809).

*Leucadendron tortum* R.Br. in Trans. Linn. Soc. **10**: 56 (1810).

Not *Protea torta* Thunb. Diss. 31 (1781) = *L. fusciflorum* (Jacq.) R.Br.

**7. *Leucadendron loranthifolium*** (Salisb. ex Knight) Williams comb. nov.

*Protea loranthifolia* Salisb. ex Knight Prot. 28 (1809).

*Leucadendron glaucescens* Schlechter mss.

**8. *Leucadendron procerum*** (Salisb. ex Knight) Williams comb. nov.

*Euryspermum procerum* Salisb. ex Knight Prot. 20 (1809).

*Leucadendron concinnum* R.Br. in Trans. Linn. Soc. **10**: 61 (1810).

**9. *Leucadendron salicifolium*** (Salisb.) Williams comb. nov.

*Euryspermum salicifolium* Salisbury Parad. Lond. 75 (1807).

*Euryspermum cuspidifolium* Salisb. ex Knight Prot. 20 (1809).

*Leucadendron strictum* R.Br. in Trans. Linn. Soc. **10**: 60 (1810). excl. syn. Lam. and Poiret.

Note: Also published in Flowering Plants of Africa, vol. **38** (1967).

**10. *Leucadendron spirale*** (Salisb. ex Knight) Williams comb. nov.

*Chasme spiralis* Salisb. ex Knight Popt. 16 (1809).

*Leucadendron scabrum* R.Br. in Trans. Linn. Soc. **10**: 65 (1810).

**11. *Leucadendron spissifolium*** (Salisb. ex Knight) Williams comb. nov.

*Euryspermum spissifolium* Salisb. ex Knight Prot. 23 (1809).

*Leucadendron glabrum* R.Br. in Trans. Linn. Soc. **10**: 60 (1810).

*Leucadendron riparium* Salter in Journ. S.A. Bot. **9** (1): 14 (1943).

***Leucadendron barkerae*** Williams sp. nov. (Proteaceae).—*Frutex* 2 m altus, *rami* erecti crassi tomentosi purpurascens, *folia* elliptica obtusa erecta nervosa sub-glaucula tomentosa mucronata 5—7 cm longa 1·3—2·2 cm lata, *folia floralia* conferta erecta colorata grandiora, *inflorescentia mascula* 4·4 cm diam, *bracteolae* lineares obtusae lateribus ciliatis 1·5 cm longae 2 mm latae, *perianthium* sparsim pubescens apicem versus glabrum, *antherae* lineares erectae, *stylus* filiformis basim versus longe pubescens, *stigma abortivum* bifidum truncatum, *inflorescentia femina* globosa 2·6 cm diam, *perianthium* dense pubescens apicem versus glabrum, *ovarium* ovoideum glabrum, *fructus* 8 mm longus 9 mm latus 4·6 mm crassus biconvexus glaber margine porcatus ad basim pubescentia.

CAPE PROVINCE. Ceres Division, Eikenbosch Hoek, *Esterhuysen* 3699 (BOL), *Marloth* 9120, 9121 (PRE, STE). Hottentots Kloof, *Pearson* 4905 (BOL, K. NBG, STE). Worcester Division, Bonteberg, *Compton* 9927 (NBG).





PLATE 1.  
*Leucadendron barkeriae*  
Habit

Laingsburg Division, Tweedside Ridge, *Compton* 2292 (BOL). Witteberg, *Compton* 3732 (BOL). North side Klein Swartberg, *Compton* 4049 (BOL), *Esterhuysen* 24834 (BOL), *Barker* 9943 (NBG), *Middelmann* 7 (NBG), *Williams* 521 (NBG) (Holotype), *Phillips* 1510 (PRE), *Andreae* 1268 (PRE), *Phillips* 9247 (SAM). Prince Albert Division, Swartberg, *Pocock* 1002 (BOL), *Williams* 526, 713 (NBG). Montagu Division, Wagenboomsberg, *Williams* 729 (NBG).

#### DESCRIPTION

*Shrubs* stout, erect, branching from the base, up to 2 m high. *Branches* numerous, stout, fairly smooth, devoid of leaves. *Branchlets* erect, stout, tomentose, purplish, males more branched. *Leaves* elliptic, obtuse, erect, veined, tomentose becoming glabrescent, sub-glaucous, with a small blunt red mucro grooved and recurved, margins thinly cartilaginous, males 5 cm long and 1.3 cm broad, females 7 cm long and 2.2 cm broad. *Involucral leaves* larger, crowded, erect, coloured, imbricating the head. *Male inflorescence* solitary,





PLATE 2.  
*Leucadendron barkerae*  
Male inflorescence



PLATE 3.  
*Leucadendron barkerae*  
Female inflorescence

terminal, flowers spreading widely when fully open, flattened above, 3.3 cm long and 4.4 cm diam, diffusing a pleasant fruity perfume. *Basal bracts* linear, obtuse, thin, glabrous, resinous, ciliate, 1.9 cm long and 7 mm broad, about 55 in number, the outer more acute and pubescent, the innermost recurved at the apex. *Floral bracts* linear, thin, long ciliate on both margins, not so at the apex where slightly broader, recurved, resinous, 1.5 cm long and 2 mm broad. *Floral bud* sparsely pubescent below, glabrous and bent above, 1.7 cm long. *Perianth tube* sparsely pubescent, 1 cm long. *Claw* glabrous, recurved 90°, 2 mm long. *Limb* linear, glabrous, 5.5 mm long. *Anthers* linear, erect, 4.5 mm long, presenting the pollen. *Pollen* triangular in polar view, sides 0.039 mm long. *Style* filiform, narrower above, long pubescent below, 1.4 cm long. *Stigma* abortive, truncate, bifid. *Hypogynous scales* filiform, 7 mm long. *Receptacle* conical above, 1.6 cm long and 1.1 cm diam. *Female inflorescence* terminal, solitary, globose, flowers at the flattened apex, sides imbricated, 2.6 cm diam, diffusing a pleasant fruity perfume. *Basal bracts* the outer acute, pubescent, the

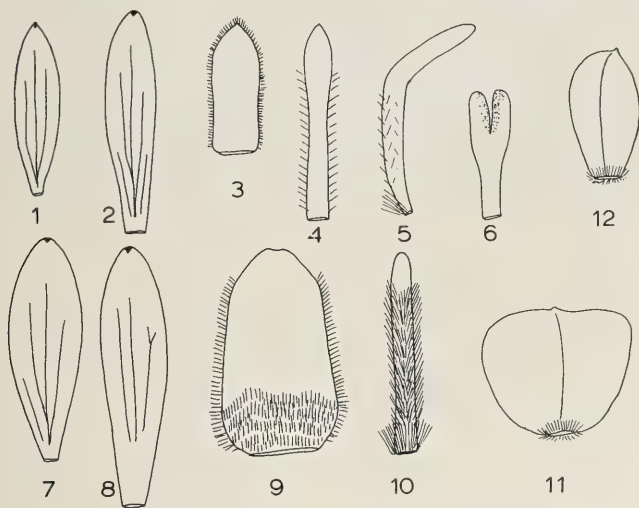


FIG. 1. *L. barkerae*

Explanation of figures:

- |                                       |                                     |
|---------------------------------------|-------------------------------------|
| 1. male leaf half size.               | 7. female leaf half size.           |
| 2. male involucre leaf half size.     | 8. female involucre leaf half size. |
| 3. male basal bract full size.        | 9. female floral bract $\times 2$ . |
| 4. male floral bract $\times 2$ .     | 10. female floral bud $\times 2$ .  |
| 5. male floral bud $\times 2$ .       | 11. fruit $\times 2.5$ front view.  |
| 6. male abortive stigma $\times 15$ . | 12. the same size view.             |

inner glabrous, resinous, oblong, obtuse, ciliate, with a small acute apex, the innermost slightly recurved, 1·8 cm long and 8 mm broad, about 56 in number. *Floral bracts* oblong, obtuse, ciliate except at the apex, glabrous and resinous above, densely pubescent below, 1·5 cm long and 9 mm broad. *Floral bud* 1·5 cm long, densely pubescent except at the apex. *Perianth tube* transversely compressed, bent in near the base, densely pubescent, 1·2 cm long. *Claw* pubescent, recurved 90°, 1 mm long. *Limb* glabrous, 2·5 mm long. *Staminode* curled upwards, 0·75 mm long. *Ovary* ovoid, glabrous, 1·25 mm long. *Style* filiform, glabrous, narrower below, 1·4 cm long. *Stigma* oblique, 0·7 mm diam. *Hypogynous scales* filiform, tapering, yellow, 3·5 mm long. *Receptacle* conical above, 1·5 cm long and 9 mm diam. *Mature female head* a cone 4 cm long and 3·3 cm diam with bracts in 8 spirals, closely imbricated at the base by the lower part of the involucreal leaves and by the numerous basal bracts. *Fruit* a nut 8 mm long, 9 mm broad and 4·6 mm thick, biconvex, margins ridged, glabrous, pubescent at the basal scar, dehiscent 3 to 4 months after anthesis.

*Leucadendron barkerae* can be distinguished from those species which are nearest to it, by the elliptic sub-glaucous tomentose leaves, by the linear laterally ciliate male floral bracts, by the truncate bifid abortive stigma and by the fruits with ridged margins but above all, if the plant can be observed in the bud stage up to several months before flowering, the buds will be seen to be quite unlike any other species. Flowering from late September to early October *L. barkerae* is found under dry conditions in an area bordering on the Karroo at altitudes of 3,500 to 4,000 feet extending eastwards from the Bonteberg to the Swartberg Pass. I have named this species in honour of Miss W. F. Barker without whose kindly encouragement I would never have entered the fascinating world of Plant Taxonomy and for whose efficient curatorship of the immaculate Compton Herbarium I have the greatest admiration.

*Leucadendron bonum* Williams sp. nov. (Proteaceae).—*Frutex* 1·5 m altus, erectus; *rami* crassi, villosi; *folia* spathulata vel late oblanceolata, argentea, utrinque pilis adpressis; *bracteae* involucrales conspicuae, flavae, angustae, longae, acutae, ciliatae, extus villosae; *perianthium* amborum sexum dense longissime villosum apex longe excedens; *stigma* femineum terminale, bifidum.

CAPE PROVINCE. Ceres Division, Gideons Kop, 4,900 ft, *Esterhuysen* 31620 (BOL) (Holotype), 31022 (BOL), *Williams* 951 (NBG), *Rourke* 666 (NBG), *H. Meyer* s.n. (STE 30111).

#### DESCRIPTION

*Shrubs* up to 1·6 m usually less, erect, single stemmed below. *Branches* few in number, stout, villous, purplish, hidden by the leaves, becoming rough, blackened and devoid of leaves with age. *Leaves* of males up to 5·5 cm long and



PLATE 4.  
*Leucadendron bonum*  
Habit

2·2 cm broad, of females up to 6·2 cm long and 2·6 cm broad, erect, spathulate, veined, densely adpressed silvery pubescent on both surfaces and edges, rounded or obtuse at the apex with a broad blunt callus largely concealed by the pubescence, narrowing to the base where the pubescence becomes longer. *Basal bracts* numerous, conspicuous, yellow, narrowly triangular, the average about 4 cm long and 5 mm broad at the base, villous outside, glabrous inside, long ciliate, acute, about 40 in number. *Male inflorescence* 2 cm long and 2·1 cm diam, solitary, terminal, sub-conical, yellow, densely woolly when in bud, diffusing a faint honey like perfume. *Floral bract* 1·7 mm long and 1·3 mm broad, triangular, glabrous, sparsely tufted at the apex. *Floral bud* 6 mm long, clavate at the apex, arched below, dense and long silky white pubescent, shaggy at the apex, standing in a tuft of straight hairs at the base. *Perianth tube* 1·7 mm long, villous. *Claw* 2·3 mm long, recurved 180°, villous. *Limb* 2 mm long, spathulate, hollow, hooked, shaggy villous at the apex. *Anthers* 1·5 mm long, linear, curled





PLATE 5.  
*Leucadendron bonum*  
Female inflorescence

upwards. *Pollen* triangular in polar view with sides 0.045 mm long, polar height 0.027 mm. *Stigma* abortive, 1 mm long, clavate, entire, acts as a pollen presenter. *Style* 4 mm long, glabrous, a little narrower above. *Hypogynous scales* 0.7 mm long, subulate, pale yellow. *Receptacle* 10 mm long and 7 mm diam conical. *Female inflorescence* 1.8 cm diam, globose, solitary, terminal, with the florets arranged in 8 spirals of 4 or 5 in each, diffusing a faint honey like perfume. *Floral bract* 6 mm long and 8 mm broad, broadly oval, obtusely acuminate, very dense and long silky pubescent below, shorter pubescent above, ciliate. *Floral bud* 6.5 mm long, densely clothed in a long white silky pubescence, standing in a dense tuft of very long hairs. *Perianth tube* 6 mm long, densely long silky pubescent, deeply divided above and also below. *Claw* 3 mm long, recurved 180°, densely long silky pubescent. *Limb* 1.5 mm long, obtuse, densely long silky bearded. *Staminodes* 1 mm long. *Stigma* 0.7 mm broad terminal, bifid. *Style* 7.5 mm long, filiform, glabrous, a little narrower below. *Ovary* 1.3 mm long, ovoid, sparsely pubescent mostly towards the apex.

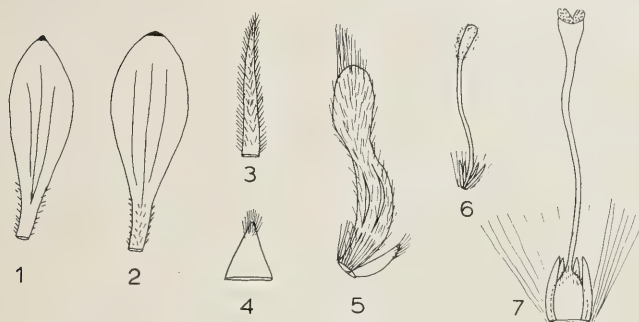


FIG. 2. *L. bonum*

Description of the figures:

- |                                   |   |
|-----------------------------------|---|
| 1. male leaf half size.           | 6. male sterile gynoecium with hypogynous |
| 2. female leaf half size.         | scales $\times 5$ .                       |
| 3. basal bract half size.         | 7. female gynoecium with hypogynous       |
| 4. male floral bract $\times 5$ . | scales $\times 5$ .                       |
| 5. male bud $\times 5$ .          |   |

*Hypogynous scales* 2 mm long, acicular, pale yellow, exuding nectar which may be seen at the throat of the perianth tube. *Receptacle* 1.1 cm long and 7 mm broad, conoidal. *Mature female head* 2 cm diam globose, pubescent, dehiscent. *Fruit* a nut, 5 mm long, 5 mm broad and 4 mm thick, bi-convex, very sparsely pubescent above, dehiscent.

*Leucadendron bonum* is a unique species from a small elevated plateau immediately to the west of the summit of Gideon's Kop in the Northern Cold Bokkeveld growing at an altitude of 4,900 feet above sea level. It is extremely rare and is known only from this locality where there are no more than fifty individuals to be found. It grows on a fairly level, hard dry sandy ground, on and amongst T.M.S. rocks. This beautiful species flowers in October and the fruit ripens in early January. Towards the inflorescence in both sexes, the stem leaves are changed into narrow acute bracts forming a conspicuous yellow involucre around the flower head. These bracts spread open in the sunlight but readily close up to protect the inflorescence under adverse conditions, a characteristic not found in any other member of the Genus. This species having perfume, nectar, a conspicuous involucre and a pollen presenter, is insect pollinated.

*Leucadendron gydoense* Williams sp. nov. (Proteaceae).—*Frutex* erectus, 1.5 m altus; *rami* glabri, colorati, aliquantum gracili, foliis haud celati; *folia* anguste oblanceolata, erectiuscula, glabra, scabrida, 4.5 cm longa, 8 mm lata; *folia florales* paucae, flavidae; *capitulum* maris flavum, depressum, 1.4 cm

longum, 3 cm diam; *perianthium* glabrum; *antherae* lineares, erectae; *stylus* pubescens; *stigma* abortivum, cylindricum; *squamae hypogynae* filiformes; *receptaculum* conicum; *capitulum feminae* ovoideum, 1·9 cm longum, 1·2 cm diam; *perianthium* in medio pubescens, supra infraque glabrum; *ovarium* sparsim pubescens; *stylus* glaber; *stigma* integrum, sub-obliquum; *receptaculum* conicum.

CAPE PROVINCE. Ceres Division, Gydo Pass, *Williams* 957 (NBG) (Holotype), *Hutchinson* 1024 (BM, BOL, K), *Guthrie* 86, 87 (BOL), *H. Bolus* 8393 (BOL, K), *Acocks & Halfstrom* 388 (PRE, S), *Compton* 20152 (BOL) partly, *Markotter* s.n. (STE 19357), *Williams* 232 (NBG), 307 (NBG). Peak E. of Tarantula Peak, *Esterhuysen* 21811 (BOL). Inkrui, *Esterhuysen* 23459 (BOL). Buffelshoek Peak, *Esterhuysen* 26365 (BOL). Tulbagh Division, Witsenberg, *Pappe* s.n. (GRA, SAM 19689). *Harvey* s.n. (SAM 13468). The Twins, Mostertshoek, *Stokoe* s.n. (BOL). Tulbagh, *Harvey* s.n. (SAM 13469).

#### DESCRIPTION

*Shrubs* 1·3 m and over, single stemmed at the ground, well branched. *Branches* glabrous, smooth, often purplish, fairly slender, not hidden by the leaves, arising from below the previous year's inflorescence. *Leaves* about 4·5 cm long and 8 mm broad in both sexes, narrowly oblanceolate, almost erect, glabrous, not shining, sub-scabrous, veined, contracted at the apex to a blunt recurved mucro, margins narrowly cartilaginous, tapering evenly towards the narrow base. *Involucral leaves* similar to the stem leaves, few in number, not much crowded, becoming yellow in the male and pale green in the female. *Male inflorescence* 1·4 cm long and 3 cm diam, solitary, terminal, depressed globose, yellow, glabrous, diffusing a strong spicy or fruity odour. *Basal bracts* up to 1·1 cm long and 9 mm broad, about 17 in number, ovate, glabrous, ciliate. *Floral bracts* 9 mm long and 1·2 mm broad, linear, acute, translucent, glabrous, very sparsely ciliate. *Floral bud* 1·2 cm long, glabrous, sharply bent, standing in a few hairs at the base. *Perianth tube* 8 mm long, glabrous. *Claw* 1·7 mm long, recurved 90°, glabrous. *Limb* 3·7 mm long, linear, hooked, glabrous. *Anthers* 3·2 mm long, linear, erect, retaining part of the pollen. *Stigma* abortive, 2·5 mm long, cylindrical, minutely cleft at the apex, acts as a pollen presenter. *Style* 9 mm long, pubescent in the lower two thirds, narrower above, connate with the perianth 1·2 mm from the base. *Hypogynous scales* 7 mm long, filiform, pale, exuding nectar at their apices. *Receptacle* 7 mm long and 6 mm diam conical. *Female inflorescence* 1·9 cm long and 1·2 cm diam ovoid with the florets clustered at the apex and with the sides closely imbricated by the basal bracts, solitary, terminal on the main branch and also often at the ends of up to three secondary branchlets arising from immediately below the main head, diffusing



PLATE 6.  
*Leucadendron gydoense*  
Male inflorescence



PLATE 7.  
*Leucadendron gydoense*  
Female inflorescence



a faint odour similar to the male. *Basal bracts* similar to the male, with the apex elevated and mucronate. *Floral bracts* 7 mm long and 8 mm broad, ovate, obtuse, glabrous except below where laterally ciliate and pubescent. *Floral bud* 9 mm long, pubescent on the sides and front in the middle, glabrous above and below. *Perianth tube* 8 mm long, transversely compressed, anterior and lateral segments pubescent except below where glabrous and divided. *Claw* 1.7 mm long, recurved 180°, glabrous. *Limb* 1.3 mm long, glabrous. *Stigma* 0.7 mm diam, semi-oblique. *Style* 9 mm long, filiform, glabrous, narrower below. *Ovary* 1.5 mm long, ovoid, sparsely pubescent. *Hypogynous scales* 4 mm long, acicular, pale, exuding nectar at their apices. *Receptacle* 1 cm long and 5 mm diam, conical. *Mature female head* 3.2 cm long and 2.7 cm diam, globose, with bracts broad, ovate, glabrous, resinous, reddened, arranged in three spirals of about six in each. *Fruit* a nut, 7.5 mm long, 1 cm broad and 5.5 mm thick, bluntly ridged on the sides, sub-retuse at the apex, very sparsely pubescent towards the basal scar, dehiscent.

*Leucadendron gydoense* may be distinguished from *L. sessile* R.Br. (= *L. venosum* R.Br. sensu Phillips & Hutchinson) by its slender branches, smaller

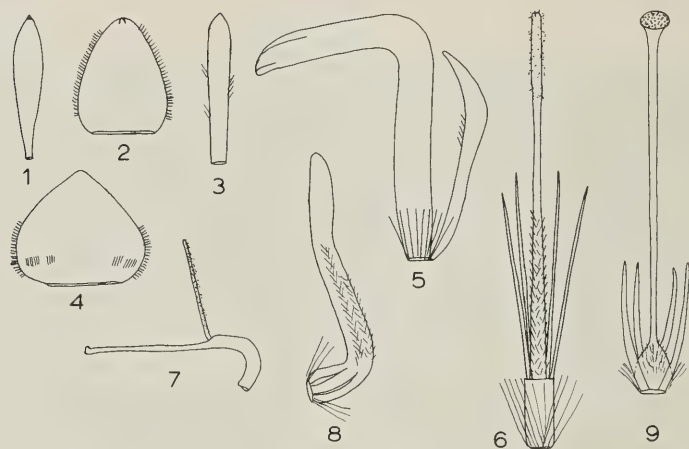


FIG. 3. *L. gydoense*

Description of the figures:

1. leaf half size.
2. basal bract  $\times 1.5$ .
3. male floral bract  $\times 2.5$ .
4. female floral bract  $\times 2.5$ .
5. male bud  $\times 5$ .

6. male sterile gynoecium with hypogynous scales  $\times 5$ .
7. anther with limb  $\times 5$ .
8. female bud  $\times 5$ .
9. female gynoecium with hypogynous scales  $\times 5$ .

leaves and sparse involucre; from *L. chamelaea* (Lam.) Williams comb. nov. (= *L. decurrens* R.Br.) by having larger rougher leaves, by having the male heads borne at the ends of branches arising from immediately below the previous year's inflorescence and not at the ends of numerous small scattered branchlets, and by having bi-convex nut like fruits not narrowly winged and ventricose; from *L. loranthifolium* (Salisb. ex Knight) Williams comb. nov. (— *L. glaucescens* Schltr. mss.) in having less glaucous leaves, a larger cone and a glabrous male floral bract.

This colourful species although known for a long time, has not been previously described. It is quite frequent locally at the summit of the Gydo Pass in the Ceres Division where it appears to hybridise with *L. chamelaea* a species which is very common in the Ceres Division. *L. gydoense* having nectar, a strong odour, a conspicuous involucre and a pollen presenter, is insect pollinated (entomophilous).



# THE IDENTITY OF *EQUISETUM CAPENSE* BURM. FIL.

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## ABSTRACT

*Equisetum capense* Burm. f. is synonymous with and antedates *Restio verticillaris* L. f.; the new combination *Elegia capensis* (Burm. f.) Schelpe is proposed.

In his *Prodromus Florae Capensis*, N. L. Burmann (1768) recorded a number of pteridophytes from the Cape, a few of which he described as new. The identities of his *Asplenium lucidum* and *Trichomanes aethiopica* were solved by Becherer (1935, 1937) who correctly referred these taxa to *Polystichum* and *Asplenium* respectively. However, the identities of *Equisetum capense* Burm. f. and of *Polypodium lignosum* Burm. f. were still in doubt.

The former was described as:

*EQUISETUM* (capense) caule tereti sublignoso glaberrimo, frondibus verticillatis, setis numerosis longissimis, internodiis divisis.

Only one species of *Equisetum*, *E. ramosissimum* Desf., is known to occur in Africa. In Southern Africa it is not recorded closer to Cape Town than the Graaff Reinet and Uitenhage districts of the Cape Province. In view of the extent of the botanical exploration of the Cape Province at that time, it seemed highly unlikely that the younger Burmann could have acquired an *Equisetum* from South Africa. In fact, the first substantiated collection of *E. ramosissimum* in South Africa was made by Thunberg, probably in the Uitenhage district in 1773. Furthermore, Burmann's description of his *E. capense*, quoted above, would not fit even the most vigorous South African forms of *E. ramosissimum*.

However this description did suggest *Elegia verticillaris* (L. f.) Kunth, a common restionaceous plant of wet localities in the south-western Cape mountains with a superficial resemblance to the large European *Equisetum telmateia* Ehrh. Subsequently a search in the Conservatoire de Botanique in Geneva brought to light Burmann's type of his *Equisetum capense* which was unquestionably a flowering specimen of this common *Elegia*. Since Burmann's *Equisetum*



*capense* (1768) antedates *Restio verticillaris* L.f. (1781), based on a Thunberg collection from the Cape and the basionym of *Elegia verticillaris* (L.f.) Kunth, a new combination for this taxon, *Elegia capensis* (Burm. f.) Schelpe comb. nov. is proposed. (Basionym—*Equisetum capense* Burm. f., Prod. Fl. Cap.: 27 (1768)).

A further search for the type of *Polypodium lignosum* Burm. f. among the ferns at Geneva was fruitless and this name may well prove to be founded on a leaf of a Cape flowering plant.

The author wishes to thank the Director and staff of the Conservatoire de Botanique, Geneva, for their help in searching for type specimens, and to acknowledge a Bremner Travel Grant from the University of Cape Town which enabled the author to visit a number of continental European herbaria.

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## GONYAULAX GRINDLEYI SP. NOV. :

A DINOFLAGELLATE CAUSING A RED TIDE AT ELANDS BAY,  
CAPE PROVINCE, IN DECEMBER 1966.

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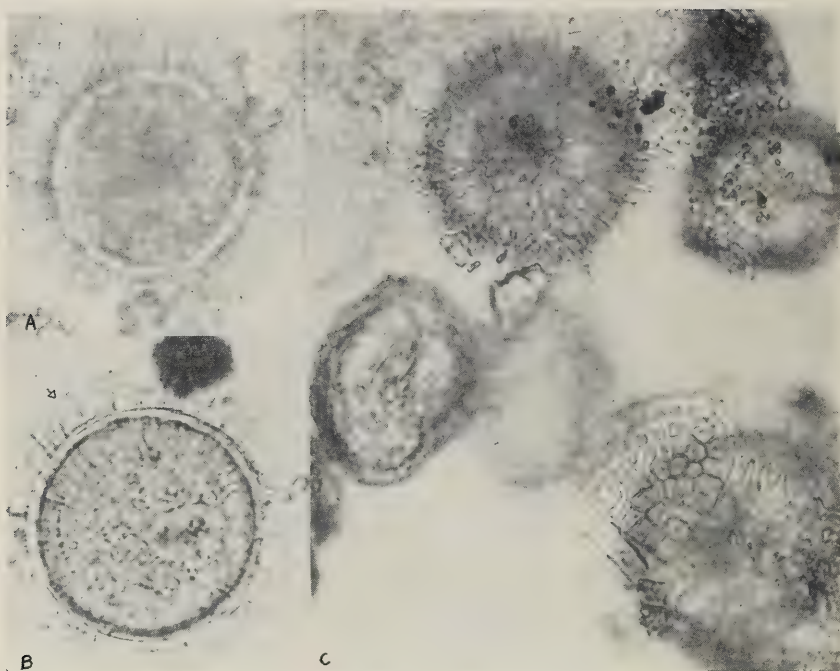
Towards the end of December 1966, a red tide was reported in the vicinity of Elands Bay, which lies about 30 miles South of Lamberts Bay in the South West Cape. The causative organism was found to be an undescribed species of the dinoflagellate genus *Gonyaulax* Diesing. A joint paper on the ecology of this red tide by Dr. J. R. Grindley of the Port Elizabeth Museum and Oceanarium, and Miss E. A. Nel of the Division of Sea Fisheries, Sea Point, is in preparation.

A feature of particular interest is that shellfish, collected in waters affected by this *Gonyaulax* bloom, yielded a paralytic toxin. These investigations were carried out by Professor N. Sapeika of the Pharmacology Department, University of Cape Town Medical School.

*Gonyaulax grindleyi* Reinecke, sp. nov.

A speciebus aliis ob parvitatem cum patella apicali prima lata, patella occludenda magna, patellis magnis reticulatis, poro in quoque polygono reticuli, differt.

*Body* subsphaeroidal, longitudinal axis slightly exceeding equatorial axis, the former in length 28—43 $\mu$ , the latter 25—35 $\mu$ ; *girdle* displacement about one girdle width, no overhang of the two ends, girdle lists prominent; *epitheca* conical, no apical horn; *hypotheca* subhemisphaerical, in dorsal view up to 1.5 times height of epitheca; *plate formula*: 3', 1a, 6'', 6, 6''', 1p, 1''''; number of intermediate plates of ventral area difficult to determine; ventral apical broad as in *G. polyedra* Stein, closing plate exceptionally large; markings of mature thecae reticulate, similar to those in *G. digitale* (Pouchet) Kofoid, but not as regular, with raised ridges which form a polygonal pattern on the larger plates, with a small pore in each polygon; where the corners of the polygons meet,



## PLATE 1.

Cysts found in water with *G. grindleyi* bloom.

*A* and *B*, cysts seen in optical section: in *B*, the arrow indicates a possible membrane around the spines; *C*, two cysts seen in surface view: note postcingular plate lying on one, the other is also shown in *A*. (Diameter of cysts excluding spines:  $36\mu$ ).

there may be a slight projection of the ridge; young thecae smooth walled, the plates clearly visible; markings on girdle plates of mature thecae faint.

**HOLOTYPE:** Iconotype Fig. 1. Type material lodged at South African Museum, Cape Town.

**LOCALITY:** Elands Bay, Cape Province, Dec. 1966, J. R. GRINDLEY.

It is difficult to place this species in any of the subgenera described by Kofoed (1911). The closing plate appears to be carried over to the dorsal side as in the subgenus *Steiniella* (Schütt) Kofoed, but in other features it has greater affinities with the subgenus *Gonyaulax* (Diesing) Kofoed.

Spiny cysts, (Plate 1), were also found in the red tide samples, and in one

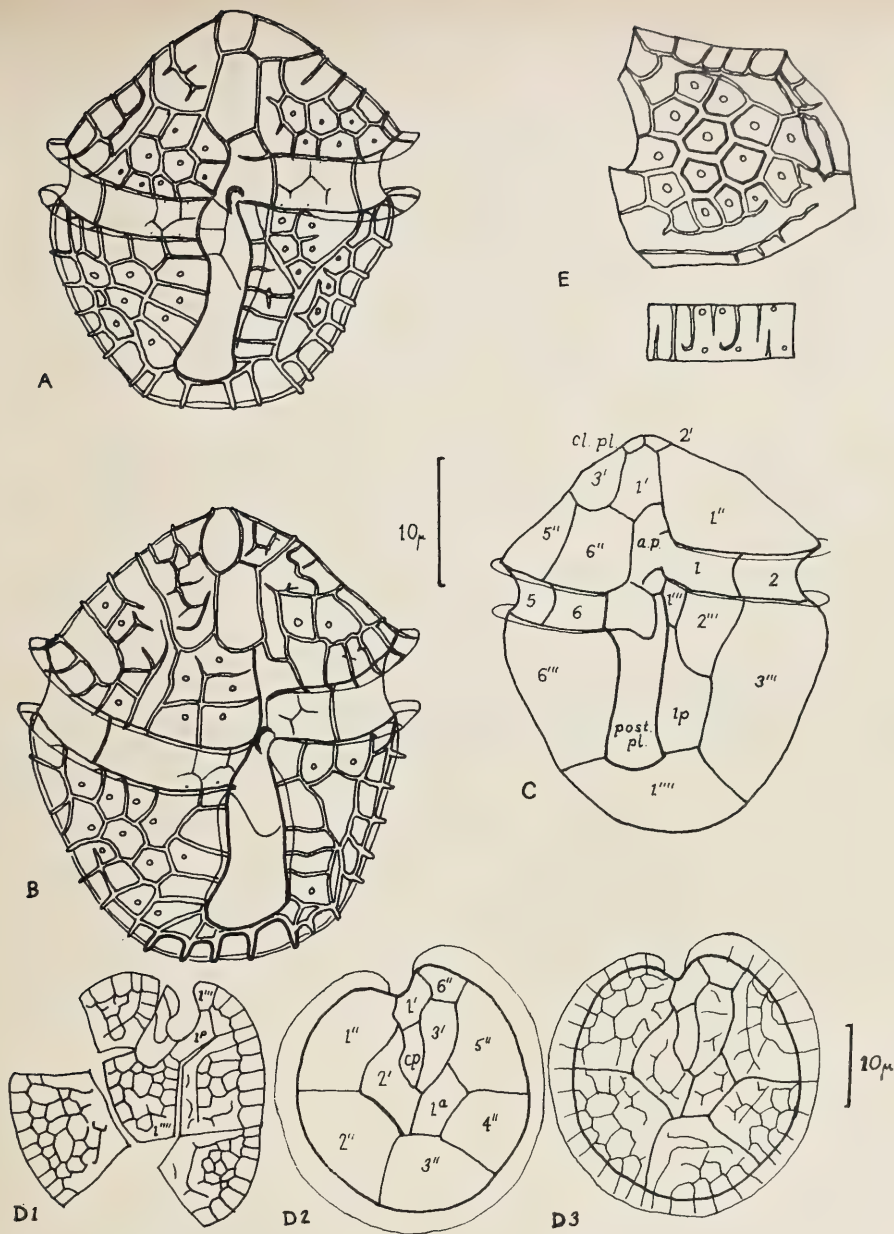


FIG. 1.

*Gonyaulax grindleyi*, from Elands Bay. *A* and *B*, older thecae seen ventrally; in *A*, the intermediate plates of the ventral area are better seen; *C*, young theca showing arrangement of plates: cl. pl., closing plate; 1'–3', apical plates; 1''–6'', precingular plates; 1–6, girdle plates; 1'''–6''', postcingulars; lp, posterior intercalary plate; 1'''' antapical plate; a.p., anterior plate of ventral area; post. pl., posterior plate of same; *D1*, antapical view of hypothecal plates; *D2* and *D3*, apical view of epithelial plates: cp, closing plate; la, anterior intercalary plate; *E*, antapical plate and girdle plate 3 or 4 from mature thecae.



such sample kept in a domestic refrigerator for a week, there was a noticeable increase in the numbers of these cysts while cells of *G. grindleyi* were no longer evident. Unfortunately, no culture studies were made and no intermediate stages were observed, so there is no direct evidence that they are, in fact, cysts of this new dinoflagellate. The diameter of the cysts examined was 32—36 $\mu$ , excluding the spines, which were 6—9 $\mu$  in length and more abundant than those on the cyst of *G. polyedra*, (Evitt and Davidson, 1964).

#### ACKNOWLEDGEMENTS

Work on phytoplankton in the Oceanographic Research Unit is financed by the Council for Scientific and Industrial Research. The author is indebted to Mr. R. H. Simons of the South African Seaweed Laboratory, stationed at the University of Cape Town, for taking the photographs and assisting with the Latin diagnosis; and to Dr. Grindley and Miss Nel for providing material, and to Professor Sapeika for information on the shellfish toxin.

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# HEURNIUS AND HERMANN, THE EARLIEST KNOWN PLANT COLLECTORS AT THE CAPE

MIA C. KARSTEN

## II. PAUL HERMANN (contin.)

Proceeding to HERMANN's writings, he is the author of two major botanical works, containing descriptions of many new plants, found in various parts of the world, including South Africa, and neat, well recognisable pictures he drew of a number of them.

The first work published by him is a catalogue of the Leyden University Garden, the title page of which is as follows: *Horti Academici Lugduno-Batavi Catalogus*, exhibens Plantarum omnium Nomina, quibus ab anno M DC LXXXI ad annum M DC LXXXVI Hortus fuit instructus ut & Plurimarum in eodem cultarum & à nemine hucusque editarum *Descriptiones & Icones* Auctore Paulo Hermanno Medicinae & Botanices Professore, Lugduni Batavorum, Apud Cornelium Boutesteyn, M DC LXXXVII<sup>45</sup>. The pictures illustrating the work are finely executed engravings.

In the autumn of 1680 HERMANN was approached by the Secretary of the Curators of Leyden University<sup>46</sup> about the fact that the conservatory ("gaelderij" as it was called in 17th century Dutch) of the University Garden contained so many plants in pots, tubs and (wooden) cases, belonging to private people who with the consent of either the professor of botany as the curator of the Garden, or the gardener in charge, had brought them there to shelter them from the winter cold, that there was not enough room left for the Academic

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<sup>45</sup> Translated from the Latin: . . . , giving the names of all the plants introduced to the Garden between 1681 and 1686 and the *descriptions* and *figures* of many cultivated there not previously published; the author being Paul Hermann, Professor of Medicine and Botany. Published by Cornelis Boutesteyn, Leyden, 1687.

<sup>46</sup> "Resoluties van Curatoren" 1680, Aug. 8, published in P. C. MOLHUYZEN, *Bronnen tot de Geschiedenis der Leidsche Universiteit*, Vol. III (1918), pp. 354-355.

collections, and expressing the view that the conservatory, and also the Garden, should be solely used for plants and trees belonging to it. Needless to say that for introduction of tropical and subtropical plants greenhouses are essential, and from HERMANN's "Dedicatio" of his *Catalogus* of the Leyden University Garden it is learnt that the necessary greenhouses were therefore built between 1680 and 1687, viz. during his curatorship, and "especially the new succulents introduced from the Cape of Good Hope found a good shelter there"<sup>47</sup>.

Among the exotic plants grown in the University Garden are a great number originating from the Cape, which are described in HERMANN's *Catalogus*. Of many species pictures are given, showing him as a skilful draughtsman.

The South African plants incorporated in the *Catalogus* show a great variety of species and genera, representing many families. The Mesembryanthemum group (Aizoaceae) and the genus Pelargonium (Geraniaceae) may be mentioned as the best represented. Since SCHUYL's<sup>48</sup> times the number of Mesembryaeae grown in the Garden increased from one to twelve. HERMANN calls these species "Ficoides seu Ficus Aizoides Africana" (Ficoides or the succulent African Figs), because of the resemblance of their fruit to that of the genus *Opuntia* ("Ficus Indica"). The English common name is still "Fig-Marigold". It appears that the collection contained the "Hottentot's Fig", *Carpobrotus edulis*, (L.) N. E. Br. (Mesembryanthemum edule), *Carpobrotus acinaciformis*, (L.) L. Bol. (M. acinaciforme), *Trichodiadema barbata*, (L.) Schwant. (M. barbatum); the latter two grown from African seed in the garden of Mr. HEEMSKERCK; further *Lampranthus glaucus*, (L.) N. E. Br. (M. glaucum), *Carpobrotus aequilateralis*, (Haw.) N. E. Br. (M. aequilaterale) which flowers all summer; *Mesembryanthemum nodiflorum*, L. and *Carpanthea pomeridiana*, (L.) N. E. Br. (M. pomeridianum)<sup>49</sup>.

One of the best and most interesting pictures drawn by HERMANN of South African plants undoubtedly is that of *Carpobrotus edulis*, covering p. 245 of his *Catalogus*, and which is reproduced herewith (Plate 1). Part of the extensive description he gives of this species (pp. 244, 246 and 247) may be quoted here

<sup>47</sup> H. VEENDORP and L. G. M. BAAS BECKING, *Hortus Academicus Lugduno-Batavus* 1587-1937. The Development of the Gardens of Leyden University (1938), p. 84.

<sup>48</sup> FLORENTIUS SCHUYL, born in 1619 at Schiedam (Holland), and died in 1669 at Leyden, was a curator of the Leyden University Garden. He published a catalogue of the Garden under the title *Catalogus plantarum horti academici Lugduni Batavi, quibus is instructus erat anno 1668. Accedit index plantarum indigenarum, quae prope Lugdunum in Batavis nascuntur. Lugduni Batavorum, apud haeredes Joh. Elsevirii. 1668.*

<sup>49</sup> These notes on the Mesembryaeae have been taken from VEENDORP and BAAS BECKING, *Hortus Academicus Lugduno-Batavus* 1587-1937. The Development of the Gardens of Leyden University (1938), p. 85.

LUGDUNO-BATAVUS. 245  
FICUS AIZOID. AFRIC. MAI. PROCUMB. TRIANG.  
FOL. FRUCT. MAXIM. EDULI.



PLATE I

*Carpobrotus edulis*, (L.) N. E. Br., drawn by HERMANN. *Horti Academici Lugduno-Batavi Catalogus* (1687), p. 245.



(translated from the Latin)<sup>50</sup>: “Ficoides, or the larger succulent procumbent African Fig, with a triangular leaf, and a large edible fruit. Common name “Hottentot’s Fig”.

“Those plants which the distinguished Paul Ammann [?] called “Kalia Africana” because of their natural appearance, and which the most expert Jakob Breynia called in his *Centuria* “Chrysanthema Aizoidea” and in his *Prodromus* “Resembling Chrysanthema”, and are in fact commonly known as “Aizoidean Asters” and “triangular Sedums”, I wish now to put forward under the name “Ficoides” or “African Aizoidean Figs”, to species of which they truly seem to belong rather than to Kalis, Chrysanthemums, Asters or Sedums. . . . (The flower) is wider than that of an Aster and is made up of numerous delicate slender petals, glittering with shining gold like the rays of the sun, encircling many like-coloured stamens furnished with mealy yellowish tips, in the middle of which are seven or eight small horns of a greenish yellow arranged in a ring. When these have withered the fruit develops, and somewhat resembles a common fig, green, pulpy, crammed with very minute seeds, as can be seen in the figure of the cut fruit, with a not unpleasant sweet watery flavour, the top centre being marked with five transverse starlike rays, with a juice which either quickly decays or in the intenser heat of the sun is converted into a mouldy mass separated into five chambers enclosing the tiny angular brown seeds. It flourishes with the other following plants of the same kind in arid sandy maritime places in the Cape of Good Hope, where the fruits are eaten by the Belgian [=Dutch!] settlers as well as by the native Hottentots . . .”

The description of this species is followed by a few notes on a variety of it<sup>51</sup>: “Grown from African seeds in the garden of Mr. HEEMSKERCK, a most diligent

<sup>50</sup> Original Latin text: “Ficoides, seu Ficus Aizoides Africana major procumbens, triangulari folio, fructu maximo eduli. Ficus Hottentottorum vulgò.

“Quas Plantas Clarissimus Paulus Ammannus in plantarum charactere naturali Kalia Africana, & peritissimus Iacobus Breynius in Centuriâ Chrysanthema Aizoidea, ac in Prodromo Chrysanthemis similes, vulgus verò Asteres Aizoideos & Seda triangularia appellant, placuit nunc producere sub titulo Ficoides, seu Ficus Aizoides Africanae, ad cujus species verius videntur accedere, quam ad Kali, Chrysanthemum, Asterem aut Sedum. . . . Asteris flore amplior, ex molleculis tenuibus numerosis petalis quasi radiis ad Solem aureo fulgore micantibus constructus, cingentibus multa concoloria stamina farinacis flavescentibus apiculis donata, quorum medium occupant septem octovè cornicula ex luteo viridantia in orbem diffusa. His marcescentibus, maturatur fructus, adaequans nonnunquam Ficum vulgarem, viridis, pulposus, granis minutissimis, veluti in Icone incisi fructus videre est, refertus, saporis dulcis aequos haud in grati, summo umbilico quinque stellatim decussatis radiis inscripto, pulpâ vel cito putrescente vel intensiori solis aestu in fungosam substantiam transeunte, quae dispescitur in quinque loculos, includentes semina exigua angulosa fusca. Luxuriat cum caeteris subsequentibus hujus sortis locis maritimis aridis sabulosis ad Promontorium Bonae Spei, ubi fructus tam à Belgis ibidem hospitantibus, quam ab Indigenis Hottentottis esitantur. . . .”

<sup>51</sup> Original Latin text: “Crevit ex seminibus Africanis in horto Dni Hemskerck, florum rariorum cultoris solertissimi. Priori omnibus notis respondet, exceptis foliis nonnihil brevioribus, ense falcatum latiori dorso imitantibus”.



cultivator of rare flowers. It corresponds with the foregoing in all respects except for the shorter leaves resembling a curved sword with a broader back".

Among the Cape plants incorporated in the *Catalogus* are the three depicted and described on p. 335 of J. B. VAN STAPEL'S *Theophrasti Historia Plantarum* (1644)<sup>52</sup>. HERMANN'S descriptions are full and accurate, more technical than the rather sketchy ones HEURNIUS gives of these plants. HEURNIUS' "Sedum arborescens promontorii bonae spei" is cited by HERMANN as "The African Sedum, shrubby, grey with round leaves. Sedum arborescens of the Cape of Good Hope. *Stapel*, 335. *Breyn. Prodr.* 47"<sup>53</sup>. There is some doubt about the identity of this plant depicted on p. 551; it is quite possibly some species other than *C. orbiculata*, L. The description (pp. 549-550) is followed by one of another Cotyledon, which is more likely *C. orbiculata*, "Plakkies" or "Hondeoor": "Also another larger shrubby African Sedum, with rounder leaves, which are glaucous and surrounded by a purple edge. *Breyn. Prodr.* 47. In dry gravelly maritime places on the Cape of Good Hope, reaching the height of a shrub . . ." <sup>54</sup> (without a picture).

HERMANN'S description of "Frutillaria crassa promontorii bonae spei" (*Stapelia variegata*, L.) is accompanied by an excellent picture of this plant (p. 53), showing flowers and the very distinctive fruit, and, separately drawn, a seed with a silky appendage. From the description the following may be quoted here (translated from the Latin)<sup>55</sup>: "The dwarf succulent African Apocy-

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<sup>52</sup> This Journal, Vol. XXIX, Jan., 1963, Plate III.

<sup>53</sup> Original Latin text: "Sedum Africanum frutescens incanum, foliis orbiculatis. Sedum arborescens Promontorii Bonae Spei. *Stapel* 335. *Breyn. Prodr.* 47".

"*Breyn. Prodr.* 47" refers to the first of two books of plates of rare plants in celebrated Dutch gardens by JACOB BREYNE, viz. *Prodromus fasciculi rariorum Plantarum* anno 1679 in hortis celeberrimis Hollandiae etc. observatarum. Gedani, 1680. *Prodr. fasc. secundus* was published in 1689. (For some notes on BREYNE and his major work *Exoticarum Plantarum Centuria prima*, published previously, vide footnote 24).

<sup>54</sup> Original Latin text: "Item Sedum majus Arborescens Africanum alterum, foliis rotundioribus, glaucis, limbo purpureo cinctis *Breyn. Prodr.* 47. Locis maritimis, aridis glariosis ad Promontorium Bonae Spei fruticis altitudine assurgit: . . ."

<sup>55</sup> Original Latin text: "Apocynum humile Aizoides siliquis erectis Africanum. Fritillaria crassa Promontorii Bonae Spei Stapel. in not. ad Theophr. 335. Hujus Plantae iconem inepto nomine Fritillariae crassae à Justo Heurnio in Belgiam transmissam, exhibet Bodaeus à Stapel in notis ad Theophrastum; Quoniam vero ico & eidem subnexa descriptio imperfecta & mendosa est, placuit, accuratiorum plantae historiam hic proponere. Locis montosis, saxosis, praeruptis, aridis ad Promontorium Bonae spei luxuriant è radice albâ exili fibrosâ, cauliculi, modo humi prostrati, modo obliquè ascendentes, . . . Culturam exigit quam Opuntia spinosa; Solem auramquè calidiorem amat, Septentrionalem verò &, hyemale frigus in tantum reformidat, ut illicè livescat, arescat & percat. Propagatur tam semine, quam avulsis ramulis, in terram depactis. Virtutem possidere cum Apocynis communem indicant acris, amarus, nauseosus sapor & virosus odor".

num with erect fruit pods. *Fritillaria crassa* of the Cape of Good Hope, according to van Stapel in the notes on Theophrastus p. 335. Bodaëus à Stapel in his notes on Theophrastus gave a picture of this plant with the unsuitable name *Fritillaria crassa*, which had been sent by Justus Heurnius in Belgium [!]; as the figure itself and the annexed description are imperfect and inaccurate, it is as well to put forward an accurate account of this plant. It flourishes on mountainous, rocky, broken, dry places in the Cape of Good Hope, growing from a slender white fibrous root with small stems, sometimes prostrate on the ground, sometimes obliquely erect . . . It requires culture like that of *Opuntia spinosa*: it loves sun and warm air, and in the North it so much dislikes winter cold that it immediately turns blue, dries up and perishes. It is propagated either by seed, or by branchlets detached and set in the soil. Its possession of properties like those of *Apocynum* is indicated by its sharp, bitter, nauseous taste and poisonous smell”.

The third Cape plant poorly depicted on p. 335 of VAN STAPEL's work, *Kniphofia uvaria*, (L.) Hook., is described by HERMANN as follows (translated from the Latin)<sup>56</sup>: “African Aloe, with a triangular, very long and very narrow leaf, and with yellow ill-smelling flowers. Cape of Good Hope, *Stapel* in the notes on Theophrastus, 336”. No picture is given by HERMANN of this Liliaceous plant.

Of the many other Cape plants grown in the Leyden University Garden and included in the *Catalogus*, the following deserve to be mentioned. The common “Arum Lily”, *Zantedeschia aethiopica*, Spreng. (Araceae), described by HERMANN as “Arum aethiopicum, flore albo odorato moschum redolente” ( . . . , with white scented flower smelling of musk); *Agapanthus umbellatus*, L'Hérit. (Liliaceae), under the strange name of “Hyacintho affinis Africana”; two Leguminosae, *Podalyria myrtillifolia*, Willd. and *Psoralea pinnata*, L.; *Gunnera perpensa*, L. (Halorrhagidaceae); *Leonotis leonurus*, R. Br., “Minaret Flower”, “Wilde Dagga” (Labiateae); and to mention just one Composite, a plant described by HERMANN as “*Calendula humilis africana*, flore intus albo, foris violaceo simplici” (*Calendula*—dwarf African, with a flower white inside, violet-coloured externally, simple (? “single”, as compared with “double”)); probably *Dimorphotheca pluvialis*, (L.) Moench, the “Rain Daisy”.

HERMANN's second work, the *Paradisus Batavus*, published posthumously, bears the following inscription on the title page: *Paradisus Batavus*, innumeris Exoticis curiosis Herbis, ex rarioribus Plantis, magno sumptu & curâ ex variis Terrarum Orbis regionibus, tam Oriente, quam Occidente, collectis, acquisitis, illustratus. Ingeniosissima & dexterrima artificum manu elaboratis iconibus,

<sup>56</sup> Original Latin text: “Aloe Africana, folio triangulo longissimo & angustissimo, floribus luteis foetidis. Iris Uvaria Promont. Bon. Sp. *Stapel* in not. ad Theophr. 336.

ad vivum aeri incisis. Eruditissimâ suâ, & magnorum in re Herbaria versatissimorum Virorum Methodicâ Descriptione, & Catalogo Plantarum. Nondum prae immatura morte Auctoris delineatarum, locupletatus. Lugduni-Batavorum, Apud Petrum van der Aa, MDCCV<sup>57</sup>.

On the next page is inscribed "Pavli Hermanni Paradisus Batavus seu Descriptio Rariorum Plantarum", followed by a small oval engraving depicting a gardener, busy putting a plant in a big tub in a botanical garden, with a church in the background.

The work is dedicated to HENRY COMPTON, Bishop of London, a well-known patron of botany, by HERMANN's widow, ANNA GEERTRUDA (=GEERTRUY) STOMPHIUS. An introduction, numbering no less than 11½ pages, is written by WILLIAM SHERARD by whom this posthumous work was edited. Following are the descriptions of plants covering 247 pages. This is followed by a list, numbering 15 pages, of plants not yet engraved on copper which HERMANN intended to deal with by means of drawings included in subsequent volumes.

The *Paradisus* is illustrated by no less than 111 copper engravings of pictures of plants made by HERMANN, but only a few Cape plants are depicted. The number of Cape plants described is far less than in his *Catalogus*. Among these are *Asclepias fruticosa*, L., "Kapok Bush", "Wilde Kapok", grown from seed sent from the Cape to HERMANN in 1690 by H. B. OLDENLAND, Superintendent of the Company's Garden, with accompanying picture; some other Asclepiadaceae, including *Stapelia variegata*, L.; various Mesembryaeae, "Ficoides Africana"; Pelargonium species, "Geranium Africanum", Composites, a few Liliaceous plants.

HERMANN's second major work has a history of its own. It is less known that it was first published as the second half of WILLIAM SHERARD's *Schola botanica*, under the sub-title *Paradisi Batavi prodromus*, in 1689<sup>58</sup>, viz. before his death. This is a list of some 1,000 plants arranged alphabetically which were in Dutch gardens at the time. There is little doubt that this list was made with the aid of HERMANN's MS. notes on exotic plants. HERMANN's pupil SIMON WARTON is stated to have worked at this publication, and a copy of this work with HERMANN's corrections and annotations was owned by HERMAN BOERHAAVE who

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<sup>57</sup> Translated from the Latin: *Paradisus Batavus*, illustrated by innumerable exotic and curious herbs and rare plants collected and obtained at great expense and trouble from various regions of the lands of the globe, both eastern and western. Illustrated with most elaborate pictures executed by a skilled hand, engraved from life on copper. With his own most learned systematic description, and that of men deeply versed in Herbarium matters, and supplemented by a Catalogue of the plants hitherto only sketched, on account of the untimely death of the Author. Leyden, at Petrus van der Aa, 1705.

<sup>58</sup> P. EDWARDS, *Some Manuscripts relating to South African Botany in the William Sherard Collection in the Bodleian Library at Oxford*, this Journal, Vol. 30, July 1964, p. 104.

succeeded him as a professor. The *Paradisus* was first published by SHERARD from HERMANN'S MS. at Leyden in 1698, as an opus posthumum. It was re-printed in 1705, edited by SHERARD, at the expense of his widow. WILLIAM SHERARD (1659–1728), a former British consul in Smyrna, a lover of plants and founder of the Professorship of Botany in Oxford University, visited Leyden several times and spent a considerable time with HERMANN, learning from him and later helping him to identify his Cape collection<sup>59</sup>. HERMANN obviously had made the acquaintance of SHERARD on a visit to England in 1682, his main objective being the gardens of Oxford and Chelsea in behalf of the Leyden University Garden.

In his writings HERMANN uses a method of classification based on fruits.

In his *Thesaurus Zeylanicus* J. BURMAN published two catalogues of Cape plants, of which the first comprises plants recorded by HERMANN, while the second contains actually those which OLDENLAND and HARTOG discovered. The list of HERMANN'S plants is entitled: "A Catalogue of African plants which Paul Hermann, Professor of Botany, once observed at the Cape of Good Hope"<sup>60</sup>. Among the plants listed, comprising as many as 765 species, including numerous duplications, are Acacias, Asclepiadaceae ("Apocynums", i.a. VAN STAPEL'S "*Frutillaria crassa*"), Haemanthus (Amaryllidaceae), various Liliaceae, Iridaceae. Of the 11 "Aloes" found on the list, including *Kniphofia uvaria* (L.) Hook., none are South African as understood to-day.

As to the whereabouts of HERMANN'S manuscripts and drawings, a draft of part of his *Paradisus* (MS. 181) and a set of skilful ink drawings of plants, some with MS. notes, made by HERMANN intended to illustrate the catalogue of plants at the end of the work (MS. 178), is to be found in the custody of the Bodleian Library at Oxford, in the Sherard Collection at present on loan from the Department of Botany, Oxford.

The Cape plants depicted include two Asclepiadaceae, under the name "Apocynum". Reproduced herewith (Plate 2) is a fine true to life picture of a climbing Asclepiad (MS. 178, folio 32), its identity leaving little doubt, viz. *Cynanchum obtusifolium*, L.f. There is no name on the sheet, but in the MSS. pre-Linnean polynomials relating to those two "Apocynums", and preceding the drawings, are given, of which "Apocynum scandens vincae pervincae folio subrotundo fructu villosa (Item 30). Herman Catalogus p. 4" ("Climbing

<sup>59</sup> Ibid.

<sup>60</sup> JOANNUS BURMANNUS, *Thesaurus Zeylanicus*, exhibens Plantas in Insula Zeylana nascentes . . . Omnia Iconibus illustrata, ac descripta (Amsterdam, 1737). *Appendix*, original Latin text: "Catalogi duo Plantarum Africanarum, Quorum prior complectitur Plantas ab Hermanno observatas, Posterior vero illas continet, quas Oldenlandus et Hartogius indagarunt". The list of HERMANN'S plants (pp. 1–23) is entitled: "*Catalogus Plantarum Africanarum*, Quas Paulus Hermannus, Botanices Professor, ad Caput Bonae Spei olim observavit".





PLATE 2  
HERMANN'S drawings.  
*Cynanchum obtusifolium*, L.f.  
William Sherard Collection, MS. 178, folio 32.  
By permission of the Bodleian Library, Oxford.



Apocynum with the subrotund leaf of a periwinkle and a hairy fruit . . .") refers to the pictured plant. This name appears on the right of folio 31.

A full page of text relating to an "Aloe" in HERMANN's handwriting (verso of folio 14) is found in the MS. SHERARD 181 mentioned above. The plant is introduced under the polynominal "Aloe Africana foetida folio longissimo et angustissimo radice lutea", Hort. Lugd. ("Evil-smelling African Aloe with a very long and narrow leaf and a yellow root", Leyden Garden), and is described as follows (translated from the Latin)<sup>61</sup>: "On account of the form and arrangement of the flower which is common to many species of aloes, it was considered right to classify it as an Aloe. They [i.e. the flowers] are tube-shaped, an inch or an inch and a half long, being deeply divided at their mouths, frequently into five, less frequently into six, segments, of a red colour, or as happens in Belgium, of a slightly reddening yellow, with an unpleasant odour. The root [i.e. rhizome] is thick, yellow, malodorous, producing a few twisted branches, spreading and turning in on one another, with a few fibres [fibrous roots] interspersed. The eaves arise in clusters from the joint of the rhizome: they are two feet long, an inch wide, sharp on both edges, one surface being keeled, the other marked on the back with a remarkable protuberance so that they appear to be triangular [?] to the observer. The scape exceeds the leaves in length, terete and when fresh of a reddish colour, juicy, bare and smooth; from the tip of this the flowers hang like grapes or clusters, just as in the racemose larger blue Hyacinth of the Cape of Good Hope". With one single correction in W. SHERARD's handwriting.

The above description does not apply to any species of the genus Aloe as now understood. There is little doubt about the true identity of the plant described by HERMANN, viz. *Kniphofia uvaria*, (L.) Hook., the "Red-hot Poker", once common on the Cape Peninsula, in swampy places. This should be identical with the species described by HERMANN as "African Aloe, with a triangular, very long and very narrow leaf, and with yellow ill-smelling flowers", with a reference to the picture with short description in VAN STAPEL's work (see p. 166, footnote 56). Find included a photograph of the greater part of this "Aloe" description in HERMANN's handwriting (Plate 3).

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<sup>61</sup> Original Latin text: "Ob floris formam et dispositionem multis aloes specieby communem, Alois subjungere placuit. Sunt enim tubulosi se unciam cum semisse longi, ad oras frequentius in quinque rarius in sex profundas crenas dissecti, coloris punicei, out quod in Belgia contingit ex flavo pallide rufescentis odoris foetidi. Radicem possidet crassam luteam foetentem in aliquot brachia tortuosa ductu in vicem inflexa divaricatam, cum nonnullis interjectis fibris. Folia e radice nodis fasciculatim assurgunt, duos pedes longa, unciam lata utriq acuta altera parte carinata, altera insigni protuberante dorso notata, ut insipienti triangula appareant. Intra haec assurgit scapus longitudine folio excedens teres in viridi puneeq succosq [?], nudus glaber cujus vertice propendent flores velut ni Hyacintho racemoso coeruleo majore in CBS uvatim seu rare matim, dispositi". ("propendent" inserted by SHERARD).

*Aloe Africana foetida*  
foliis longioribus & angustioribus  
radice lutea, ~~floribus~~ <sup>longis</sup>  
~~hujus~~ <sup>ob</sup> floris formam  
et dispositionem, multis  
aloe speciebus communem,  
aloe subregere placuit.  
Sunt enim tubulari, se uicem  
cum semine longi, ad oras  
~~se~~ frequentius in quinque  
rarius in sex profundas  
crenas directi, coloris  
purpurei, aut quod in Bel  
gia contingit ex flavo palli  
de rufescentis odore fe  
tidi. Radicem porrectam  
crassam luteam foeten  
tem in aliquot brachia  
tortuoso ductu in vicem in  
flexa divaricatam, cum  
nonnullis interjectis fibris.

propendens  
teret. in viridi purpureo  
sub glabro  
57/14 e. cujus vertice floris  
velut in Hyacintho

PLATE 3.

Example of HERMANN's handwriting.

Parts of a description of an "Aloe" (*Kniphofia uvaria*, (L.) Hook.), in the William Sherard Collection, MS. 181 (verso of folio 14), the cut at the bottom showing a correction by SHERARD.

By permission of the Bodleian Library, Oxford.

LINNAEUS paid tribute to HERMANN, as an outstanding figure in the history of South African botany, by naming after him the genus *Hermannia* (Sterculiaceae), numbering over 300 species, for the greater part indigenous to South Africa. They are herbs, shrubs and undershrubs, with scarlet, orange or yellow hanging twisted flowers.

In addition to a photograph of Folio 1 of Vol. 75 of the Sloane Herbarium, showing a specimen collected by HERMANN and identified by N. S. PILLANS as *Hermannia triphylla*, Cav.<sup>62</sup>, a picture of *H. cristata*, Bolus is reproduced herewith (Plate 4). This drawing was made by the author of a specimen collected on a hill NE of Mbabane in October, 1961. *H. cristata* is an attractive plant with its bright scarlet flowers, and certainly one of the most beautiful of the genus. The former species whose flowers are yellow, is recorded as widely distributed from the Cape Province to Kimberley, and as having the most variable habit of growth in the genus.

Portraits of HEURNIUS and HERMANN have not been found up to now. Thorough investigations by Mr. L. VOGELZANG, Librarian of the Rijks-herbarium (State Herbarium), Leyden, in this respect were unsuccessful.

#### ACKNOWLEDGMENTS

I want to express my sincere thanks to Miss PHYLLIS I. EDWARDS, Librarian of the Botany Department, British Museum (Natural History), London, for her most generous assistance: she even took the trouble to examine HERMANN'S MSS. and drawings in the Bodleian Library at Oxford, resulting in the reproduction herewith of one of HERMANN'S drawings of Cape plants and of an example of his handwriting. She also kindly let me have photostats of pages from REES' *Cyclopaedia* and DANDY'S *Sloane Herbarium*, providing valuable information. I am also greatly indebted to Mr. P. W. THIELE of the Manuscript Department of the Rijksherbarium at Leyden, who provided me with welcome biographical records, including photostats of pages from the works by MOLHUYZEN, MOLHUYZEN and BLOK, and VAN DER AA; to Miss MARY D. GUNN, Librarian, Botanical Research Institute, Pretoria, for her bibliographical research, resulting in the information I wanted, and for kindly sending me photostats of pages from HERMANN'S *Catalogus* of the Leyden University Garden, LINNAEUS' *Flora Zeylanica* and WÄNNMAN'S *Flora Capensis*. I am grateful to Prof. R. H. COMPTON, Mbabane; Mrs. L. ROLLO, Cape Town, and Dr. F. G. VAN DER RIET, Librarian, Rhodes University, Grahamstown, for translations from the Latin. Finally I should like to express my gratitude to Dr. W. PIECHOCKI, Chief

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<sup>62</sup> This Journal, Vol. 33, April, 1967, Plate, p. 121.



PLATE 4  
*Hermannia cristata*, Bolus.  
Hill NE of Mbabane, October, 1961. M. Karsten del.

Archivist, Stadtarchiv (Municipal Archives), Halle (Saale), Germany; and the Reverend F. L. VAN 'T HOOFT, Wijk bij Duurstede, Holland, for research resulting in certain biographical records.

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HEURNIUS: *Lijst van Predikanten van Wijk bij Duurstede* [List of Clergymen of . . . , Holland.]

HERMANN: Stadtarchiv Halle (Saale) in Saxony, Germany (Deutscher Demokratische Republik).

## CORRIGENDUM

To JUSTUS HEURNIUS, this Journal, Vol. XXIX, part 1, January, 1963:

On p. 27 it is recorded that HEURNIUS' death occurred between September, 1651, and September, 1652. After the HEURNIUS paper was published, it was found by the Reverend F. L. VAN 'T HOOFT, Wijk bij Duurstede, Holland, that



in the *Lijst van Predikanten van Wijk bij Duurstede* [List of Clergymen of . . . ] the dates 1640–1653 are given, but without HEURNIUS' name. There is little doubt that these relate to HEURNIUS. Accordingly, the year of his death should be 1653.

ADDENDUM

To PAUL HERMANN, this Journal, Vol. 33, part 2, April, 1967:

Later research revealed that HERMANN was the son of JOHANN HERMANN, a well-known organist, and MARIA MAGDELENA RÖBER, a clergyman's daughter.



# A NEW ERICA FROM THE SOUTHERN CAPE AND NOTES ON *ERICA DESMANTHA* AND *E. COCCINEA* L.

H. A. BAKER

## ABSTRACT

A new species of *Erica* from the southern Cape is described with illustrations. A new description of *E. desmantha* was made necessary from the study of material collected from a wide area, the type having been based on only one collection from an area not clearly defined.

***Erica hendricksei*** H. A. Baker sp. nov. (*Ericaceae-Ericoideae*) Callista.

Fruticulus erectus, virgatus, circa 45 cm altus. *Caules* tenues sed robusti quum inter Restionaceae, aphylli. *Rami* pro parte maxima ad apice, ramulosi, pubescentes, glabrescentes. *Folia* 4—nata, 6—8 mm longa (petioli inclusi), erecto-patentia, arte imbricata, linearia, acuminata, carinata, leviter sulcata, rubromucronata, glabra, plerumque ciliata. *Flores* terminales, subsessiles, solitariae; pedunculi 2 mm longi, pubescentes; bracteae medianae, foliaceae ad margines scariosos, ciliatae pilis longis et pilis brevioribus glanduliferis admixtis, sulcato-carinatae, concavae. *Sepala* 8—9 mm longa, ad dimidium tubi corollae attingens, similia bracteis sed marginibus scariosus latioribus. *Corolla* circa 13 mm longa, 1 mm lata ad basem, fauce aliquanto dilato, sicca, plus minusve minute hispida; tubus primo luteo-viridis, cum lobis rubris, demum rubrescens ab apice versus fundum; lobi circa 6 mm longi, 4 mm lati, stellato-patentes, contorti, ovati, extra ruberi vel interdum rosei, intra lineolato-granulati, albi vel interdum rosei. *Filamenta* valde gracilia; antherae  $\frac{2}{3}$  mm longae, inclusae, prope basin dorsifixae, oblongae, obtusae, diluto-bruneolae, muticae; poro dimidium lobi aequante. *Ovarium* ovoideum, glabrum; stylus exsertus; stigma capitatum.

**Var. alba;** A forma typica ita differt; apices mucronati foliorum, bractorum et sepalorum diaphani, non rubri; flores parviores, tubus corollae 10—11 mm longus, perdilutus vel albus; albus in lateribus ambabus loborum; totum brunescens post maturitatem.

Erect, virgate to 45 cm or so. *Stems* when, as normally, growing in large colonies amongst *Restio* in boggy conditions, long and bare. *Branches* mostly at the top of the stems, rather few, with numerous pubescent, glabrescent,



PLATE 1.  
*Erica hendricksei* H. A. Baker.  
Colony.



PLATE 2.  
*Erica hendricksei* H. A. Baker.  
Aprox.  $\times 1\frac{1}{2}$ .

branchlets. *Leaves* 4—nate, 6—8 mm long (inclusive of petiole), erect-spreading, closely imbricate, linear-acuminate, keeled, faintly sulcate, with a red mucronate tip, glabrous, more or less ciliate. *Flowers* terminal, subsessile, solitary on short branchlets, more or less clustered together; peduncles 2 mm long, pubescent; bracts median, lanceolate, acuminate, foliaceous, scarious-edged, ciliate with long, soft, hairs and some short, glandular, hairs admixed, sulcate-keeled, concave, mucronate. *Sepals* 8—9 mm long reaching to more than half the length of the corolla-tube, similar to the bracts but with a broader scarious-edged base. *Corolla* about 13 mm long, 1 mm wide at the base, cylindrical, widening very slightly upwards, dry, more or less minutely hispidulous, the tube yellowish-green at first, with red, contorted lobes, becoming red from the top down as the flower matures; lobes about 6 mm long, 4 mm wide, stellato-patent, contorted, ovate, the outside red or rosy, the inside with a lineate-granulate indumentum, white but sometimes rosy when the colour appears between the white granules. *Filaments* very slender; anthers  $\frac{2}{3}$  mm long, included, basally-dorsifixed, oblong, obtuse, pale brownish-yellow, mucous; pore about half the cell. *Ovary* ovoid, glabrous; style included; stigma capitate.

**Var. alba;** as the type but the mucronate tips of the leaves, bracts and sepals diaphanous, not red; the flowers smaller, the corolla-tube 10—11 mm long, very pale or whiteish, the lobes white on both surfaces, the whole turning brown after maturity, not red as in the type.

CAPE PROVINCE. Caledon District. In the boggy edges of four or five marshes north of the Klein River mts. above Stanford at about 1,100 ft, *Baker* 2641 (holotype in the Bolus Herbarium), *Baker* 2644 (paratype); var. *blanda* in adjacent marsh, *Baker* 2642 (holotype in Bolus Herbarium).

Flowers late summer and autumn.

This species has been collected previously only by Stokoe in 1926 in "Klein River Mts." which may be the same locality or near to it. *Stokoe* s.n. (SAM 69693) (NBG 37695).

*E. hendricksei* resembles *E. lawsonia* Andr. in some respects and *E. infundibuliformis* Andr. (Syn. *E. pavettaeflora* Salisb.) in others, hereafter referred to as (a) and (b) respectively. The corolla is not inflated below as in (a) and is narrower, the shape being more like that of (b) but much shorter and hispidulous. The sepals are longer compared with the corolla than in either and those in (b) are not scarious-edged. The colour is unlike either, the corolla-tube always being greenish-yellow at first. This feature is very conspicuous in the maturer buds in which the lobes are red or pink before opening out and this colour gradually spreads down the tube as the flower matures; the lobes are longer and broader and less acute than in either and vary in colour from red to pink on



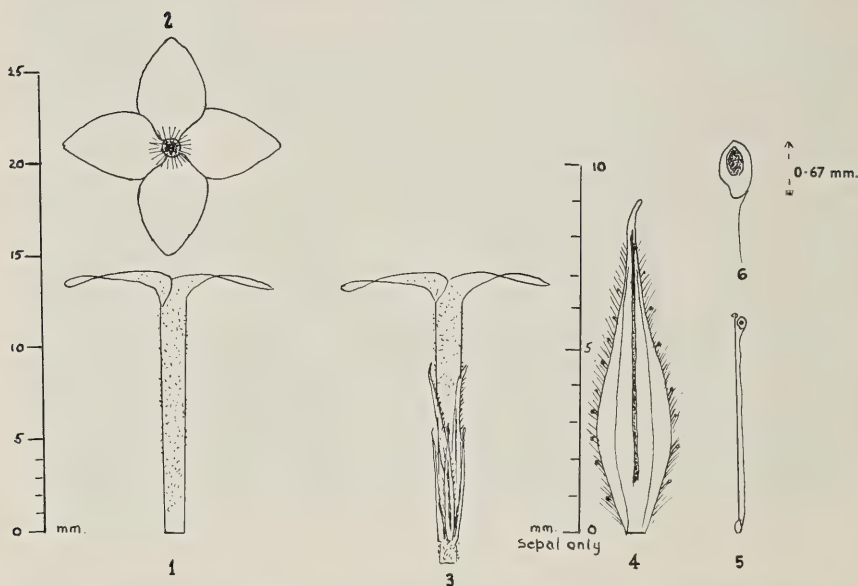


FIG. 1. *Erica hendriksei* 1. Corolla; 2. do. top view; 3. Flower; 4. Sepal, spread out; 5. Gynoecium; 6. Anther, side view.

Del. H. A. Baker.

the outside in the species to white in the var.; the inner surface is clothed with a multitude of little white granules arranged in lines, making it appear white but, sometimes, the colour seems to show through between the lines making it appear pink; after maturity they close up and become discoloured. The type specimen and the var. really represent the two extremes in colour variation, but the white var. occurs in a different marsh by itself.

#### ACKNOWLEDGEMENTS

This species was first noticed by the author in a Cape Town suburban florist shop, the owners of which kindly introduced him to Mr. S. J. Hendrickse of the farm Glenhart, near Caledon, on which it grows. Mr. Hendrickse has a large expanse of Ericaceous heath and has started a wild flower nursery to maintain the stock. The author is indebted to him for his interest, for showing him the sites, allowing him to collect specimens and for collecting the specimens of var. *alba* for him. The species has been named in his honour.

He is also indebted to the curators of the Bolus and Compton Herbaria for

allowing him the use of their facilities and particularly to Mr. J. P. Rourke of the latter for his assistance with the high-power microscope.

*Erica desmantha* Benth. in D.C. Prodr. 7: 620 (1838); Guthrie & Bolus in Fl. Cap. 4:241 (1905).

This fine, erect species grows, sometimes in large colonies, on the higher mountains of the South Western Cape. When *Flora Capensis* was written the only known material seems to have been the very small sprig in the Herbarium at Kew. This was collected by Masson, no locality given, and is Bentham's type. Since then it has been collected in several localities in the Paarl, Stellenbosch and Caledon Districts and it has become apparent that it varies considerably in the shape and size of the floral parts in different areas and that the type form is, possibly, not the most common. The description in *Flora Capensis* has thus become not only obsolete but actually misleading since the main division in the key to the section, depending on the length of corolla being twice that of the sepals or more, is no longer valid. This character is very variable and often the corolla is distinctly calycine.

The description following is based on the material now available. In the case of *Stokoe* 8336 and 7735, however, the corolla is so much different in shape that it has been found necessary to make a new variety.

#### DESCRIPTION

Erect, robust shrubs up to 1 m (3 ft) high. *Branches* with short, imbricate branchlets throughout, tomentose with hairs of mixed lengths, some of them branched. *Leaves* 3—nate, 4—6 mm long, more or less spreading, linear, sulcate, glabrous, very shortly setose-ciliate; petioles about 1.5 mm long. *Flowers* 3—nate, terminal, calycine or subcalycine; peduncles 2—4 mm long, pubescent; bracts approximate, sepal-like but smaller and usually narrower. *Sepals* 2—4 mm long, erect or spreading, imbricate, the inner ovate-lanceolate or broad-ovate, the outer broad-ovate to suborbicular, concave, keeled and keel-tipped, the tip revolute above and gland-ciliate on the margins, setose-ciliate mainly on the middle portion, scarious, white, the colour, unlike that of the corolla, persistent long after maturity. *Corolla* 3—5 mm long, mostly obconic-tubular, subtetragonous, viscid above probably from the glands on the sepals, glabrous, white soon turning brown after maturity; lobes 2 mm long, continuous or slightly spreading at the tips, obtuse and, sometimes, crenulate. *Filaments* dilated below the anthers; anthers exserted, 1.5 mm long, subterminal, oblong, bipartite, black, mucous; pore large. *Ovary* oblong, glabrous; style exserted; stigma capitellate.

**Var. *urceolata*** H. A. Baker var. nov. like the type but *Peduncles* up to 6 mm



PLATE 3.  
*Erica desmantha* Benth.  
Sprig. approx.  $\times 3$ .

long. *Sepals* suborbicular, 4 mm long, 3 mm wide. *Corolla* broad-urceolate, 5 mm long; lobes 1.5 mm long, slightly spreading at the tips, crenulate and retuse.

A forma typica ita differt: *Pedunculi* ad 6 mm longi. *Sepala* suborbiculata, 4 mm longa, 3 mm lata. *Corolla* late urceolata ad 5 mm longa; lobi 1.5 mm longi, leviter patentibus apicibus, crenulati et retusi.

#### DISTRIBUTION

SOUTH AFRICA without locality, *Masson*. (Holotype in Herb. Kew.)!

CAPE PROVINCE. Amongst dense vegetation in rather wet places from 2,500–5,000 ft).

STELLENBOSCH DISTRICT. Dwarsberg, Jonkershoek, *Rycroft* 2124 June 1958 (NBG); Banhoek Peak, S.E. slopes, *Rourke* 747, 31 March 1967 (NBG).

CALEDON DISTRICT. Bushman's Castle forest reserve, *Stokoe* 18649 April 1927 (NBG, SAM) 41922; Somerset Sneeuwkop, *Stokoe* 5007 March 1937 (BOL, NBG, SAM), *Esterhuysen* 27068 Feb. 1957 (BOL); Moordenaarskop, *Stokoe* s.n. (SAM 55385); Kogelberg, *Stokoe* 974, Aug. 1924 and Dec. 1923 (BOL), *Oliver* s.n. Feb. 1966 (STE 30073), *Rourke* 315 Feb. 1966 (NBG); summit of Beacon Mt., near Betty's Bay, Hangklip, *Stokoe* 7930 Apr. 1936 (BOL); Palmiet River valley mountains, *Stokoe* 1922 (BOL); Emerald Dome, *Esterhuysen* 10098 Apr. 1944 (BOL).

Note. For some *Stokoe* collections there is no date and three specimens collected at different places and times have the same number, 339, which has been omitted above.

**Var. urceolata**, Klein river mts. east of Rockland Peak 2,500–3,000 ft. *Stokoe* 8336 May 1941, Holotype (NBG), Isotype (SAM 55073), *Stokoe* 7735 Sept. 1940 (SAM, BOL).

Flowering season. February to August.

#### ACKNOWLEDGEMENTS

The author is indebted to Mr. E. G. H. Oliver and Mr. J. P. Rourke for assistance and advice and to the curators of the Bolus and National Botanic Gardens Herbaria for the use of facilities there.

The authors of "Ericas in Southern Africa", which is to be published in the spring, have decided that, as this species is so very variable, the resurrection of *E. follicularis* Salisb. by Dulfer in Ann. Natur. Hist. Mus. Wien 68: 29 (1965) and the placing in it of two of the varieties of *E. coccinea* L., described in Flora Capensis under *E. petiveri* L., is undesirable. Of these vars. *willdenovii* is the same as *E. follicularis* and so disappears. When Salter in Journ. S.A. Bot. 8: 279 (1942) changed *E. petiveri* to *E. coccinea* he did not cite the basionyms of

the vars. and it is necessary, therefore, to make a comb. nov. for each, where not already done by Dulfer.

The varieties of *E. coccinea* L. will now be:

Var. *pubescens* (Bolus) Dulfer l.c., 29 (1965).

Var. *intermedia* (Benth.) Dulfer l.c.

Var. *willdenovii* (Bolus) H. A. Baker comb. nov.

*E. petiveri* var.  $\beta$  Thunb. Diss. Eric. 21 (1785), var. *willdenovii* Bolus in Fl. Cap. 4: 47 (1905).

Var. *melastoma* (Andr.) H. A. Baker comb. nov.

*E. melastoma* Andr. Col. Heaths t. 37 (1802), Heathery t. 30 (1804).

*E. petiveri* L. var. *melastoma* (Andr.) Benth. in D. C. Prodr. 7: 622 (1838).

Var. *inflata* H. A. Baker in Journ. S.A. Bot. 24: 75 (1958).



# STUDIES IN RECENTLY DEVELOPED GROUP-FORMING PROCEDURES IN TAXONOMY AND ECOLOGY

A. V. HALL

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## ABSTRACT

Some important properties of methods of forming groups in taxonomy and ecology are briefly discussed. An illustration is given of the inappropriateness of using Heterogeneity Analysis, a new group-forming procedure, and perhaps also Information Analysis, for grouping samples rather than unique items. A means of detecting classes and super-classes in dendrograms is described. Using these concepts, several tests of the use of heterogeneity functions for taxonomic and ecological grouping problems are described and evaluated. An outline is given of the computing procedures used in this work. It is concluded that Heterogeneity Analysis shows considerable promise for group-forming studies.

## THEORETICAL CONSIDERATIONS

Recently, new systems of forming polythetic sets in Taxonomy and Ecology, using group heterogeneity, were briefly outlined (Hall, 1967). In the matrices of trial linkages of each member or group with every other, fusions are chosen which give the least heterogeneous groupings. After each fusion, the heterogeneity values between the new group and others are calculated in a way that uses all the raw data for each of the individual members taking part in the trial links. The majority of other group-forming procedures involve averaging methods when more than two members are compared, leading to significant losses of information.

Information analysis (Lance and Williams, 1966a) is closely related to Heterogeneity Analysis in that all the raw data about the members of a trial grouping are considered in calculating the value for choosing the best fusion. However, only two-state data coded as 0 or 1 may be used with the Information Statistic. Attributes which are zero for all members of a subset are ignored. This would give rise to difficulties for Taxonomy, where similarities based on either of the two states may be equally important, and where subdivision of the attribute cannot be allowed because of consequent extra weighting. The Information Statistic is clearly more suited to the presence/absence data of Ecology. Common

absences of a given species in a subset of plots are not significant and may be quite appropriately ignored. Even in Ecology, however, the Information Statistic would not seem to be ideal in its present form, as abundances are not taken into account. Often important ecological changes are expressed chiefly in terms of altered frequencies, especially in species-poor areas.

1. *Difference between grouping Samples and Unique Items:* Both Information Analysis and Heterogeneity Analysis appear to be unsuited to grouping samples, and should be reserved for sets of unique items such as the species in a genus or the vegetation types in a given region. This was evident in an application of Heterogeneity analysis to a vegetation study in the present work, and may be illustrated by the following example.

At an advanced stage in a grouping study, three subsets A, B and C remain to be linked. Each represents a different kind of vegetation. It happens, however, that there are thirty sample plots for each of the vegetation types A and B, and only one for C. (See Fig. 1). Of all three, C is the most distinctive kind of vegetation. If A and C were competing for linking on to B, the single sample plot of C might cause a smaller increase of heterogeneity (or lowering of Information content) than the thirty samples of A. In this way, C, although representing a more peculiar vegetation type, would take precedence over A in linking to B.

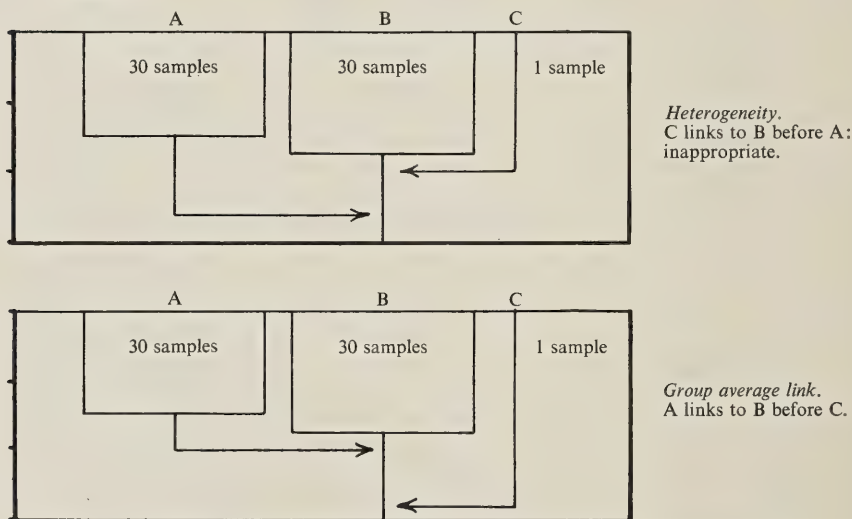


FIG. 1. Dendrograms illustrating the linkage of a poorly represented but distinctive class (C) by the heterogeneity and group average systems.

This fallacious result would be avoided by programming the test for linkage as: how different are the classes of such things as A, B and C? In such a method, the value to be obtained in each comparison is the average of the results of linking each sample in a group to all, respectively, in the other group. This is known as Group Average Linkage (Lance and Williams, 1966b; Sokal and Michener, 1958). The results given by such a study may then be interpreted to give classes, each consisting of a group of one or more samples (see below). These classes may then be fitted together to form the most homogeneous groups possible, using Heterogeneity or if desired Information Analysis, with data that is averaged no more than within each class.

2. *Detecting Classes and Super-Classes:* Broadly speaking, classes may be recognised when the proportional extensions of diversity for the groups in a given link, and for subsequently added subsets, are abruptly larger than usual. This denotes a change from the compact grouping conditions one expects within a class, to the much more diverse situation when classes are brought together. This is illustrated in Fig. 2, where for subset E,  $c^1/c > b^1/b$ , and a similar condition exists for subsets F, G and H.

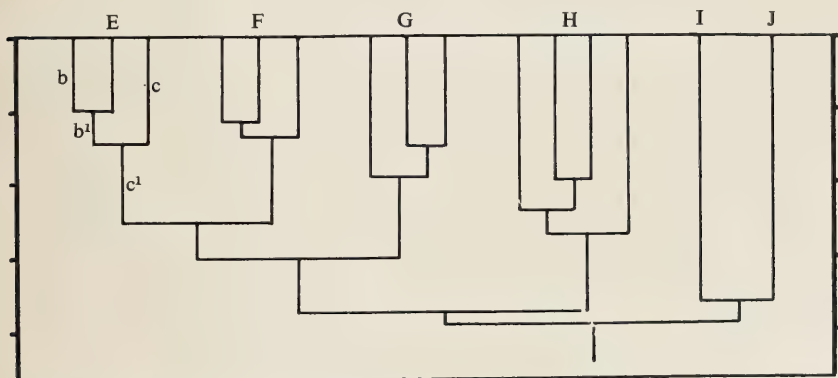


FIG. 2. Dendrogram for illustrating interpretation procedure. (For explanation, see text.)

A special case is shown in Fig. 2 by I and J, which individually are "highly compact", in fact single-membered, "groups". Together they form such a relatively poor group that they are best considered as distinct classes in their own right. Super-classes may be detected by re-applying these principles to the dendrogram in the same way, except for regarding the already-formed classes as single members.

Using personal judgement, this system gave generally reasonable results in the present studies. It is hoped to test it further in a numerical form suitable for the computer. Heterogeneity values, which seem to give a direct measure of compactness, are particularly suited to this treatment. It may be noted that the Phenon Line system of Sokal and Sneath (1963, p. 251) would not seem to be quite adequate for the case in Fig. 2: a level distinguishing E, F and G would cut across subset H in an unsatisfactory way.

#### TESTS OF HETEROGENEITY FUNCTIONS

1. *Test of Heterogeneity Function for Two-state Data:* The function for two-state data having a form that is insensitive to whether the group is odd- or even-numbered (Hall, 1967), was used in this study. For the  $j$ th of the  $p$  attributes, the actual number of rare states  $a_{jr}$  is divided by the value  $a_{jrh}$  that would be obtained for the rare states of an imaginary, maximally heterogeneous case, having the same number of included members. The function may be written as follows:

$$H_t = \frac{1}{p} \sum_{j=1}^p \frac{a_{jr}}{a_{jrh}}$$

The two-state data compiled for the 40 South African taxa of *Eulophia* (Orchidaceae) for a previous study (Hall, 1965), were used in testing this function (see Fig. 3). 93 attributes were used in the description of the taxa.

In spite of this large number of attributes, there were several cases where at a given heterogeneity level, more than one pair of groups could be chosen for linkage. Of a total of 24 possible alternatives, many appeared to involve only minor changes in the positions of members, leaving the subsequent structure unaffected. Three pathways that resulted in different positions of larger groups were investigated. The case that gave the highest total homogeneity (on average, the most compact grouping), was chosen for detailed study.

The total homogeneity values were in fact quite similar: 27.79979, 27.64826 and 27.54613. It remains to be investigated whether a better strategy would be to weight each level by a factor based on the number of included members: it would seem that the homogeneity (compactness) of the larger groups may be more important than for the smaller in seeking the best structure. In the present study, the sums of the values for the last five links show much the same relationships between the three alternative cases as the totals for all the linkages. On neutral grounds also, the groupings in the numerically best case appear to be more logical.

The structure shown in Fig. 3 is similar in many respects to that given in the

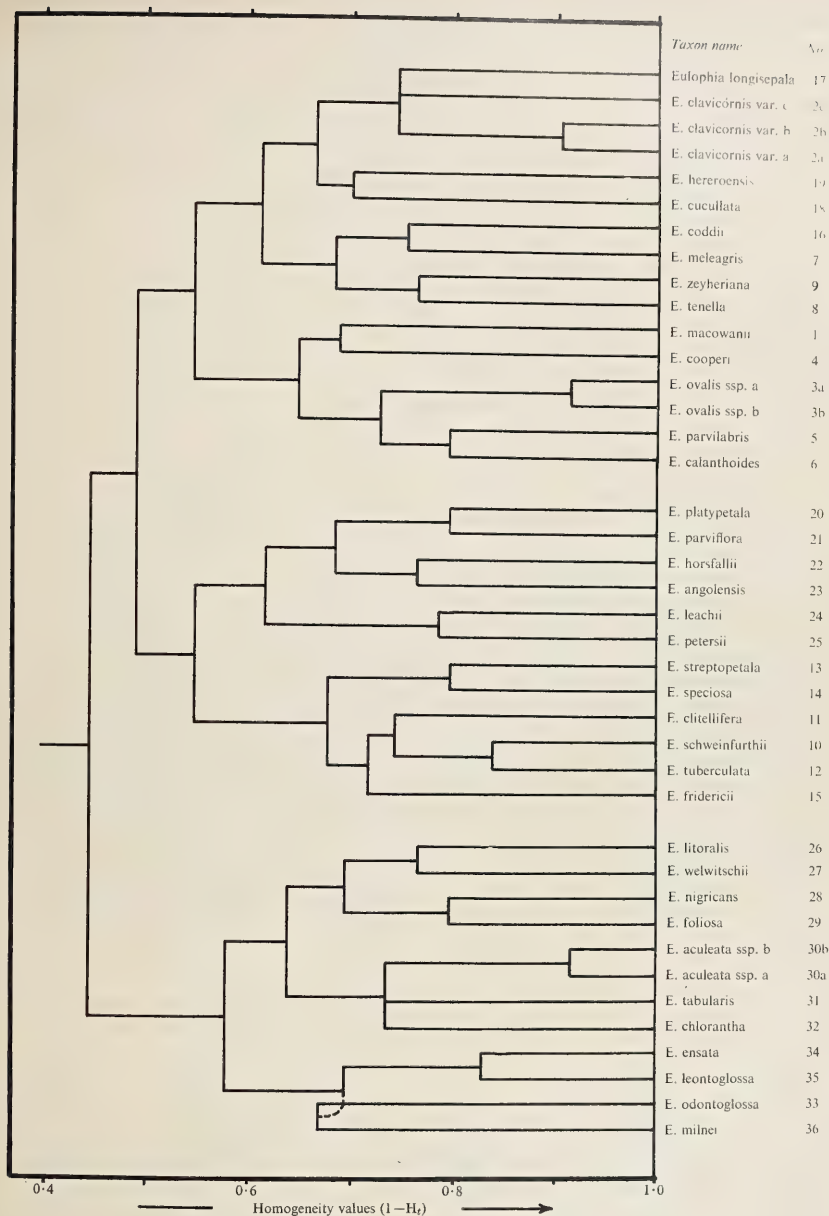


FIG. 3. Homogeneity dendrogram of the South African taxa in the genus *Eulophia*, based on 93 two-state coded attributes. The taxon numbers are the same as those used in a previous study (Hall, 1965).



former study with this data (Hall, 1965, p. 54), using the simple matching coefficient  $S_{sm}$  of Sokal and Michener (1958), with the weighted pair-group linking system (Sokal and Sneath, 1963). According to the scheme proposed earlier in this paper, the  $S_{sm}$  dendrogram shows four quite clear groups (taxa 1-6, 7-15, 16-25, 26-36), each of which is not easily subdivided. In the heterogeneity ( $H_t$ ) dendrogram three main groups may be detected (in Fig. 3, taxa 17-6, 20-15, 26-36), two of which may be subdivided (17-8, 1-6; 20-25, 13-15).

Comparing the two dendrograms, both have a generally similar structure in the groups that have less than three or four members. Among the larger groups the *Eulophia litoralis* cluster (26-36) is about equally distinctive, and in both cases has the same contents linked in a somewhat similar way. The arrangement in other large groups differs somewhat and in the majority of cases the heterogeneity dendrogram seems more appropriate.

The rather distinctive *E. streptopetala* group (13-15), formerly appearing as scarcely distinguished from *E. meleagris*, *E. tenella* and *E. zeyheriana*, is suitably isolated in the  $H_t$  structure as a sub-group linked with the somewhat similar *E. platypetala* group (20-25). *E. meleagris*, *E. tenella* and *E. zeyheriana* are more appropriately placed elsewhere (cluster 17-8). Similarly, the set containing *E. ovalis* and appropriately, *E. macowanii*, is rather better placed in the  $H_t$  analysis as a distinct sub-group. *E. hereroensis* and *E. cucullata*, however, do not seem as well positioned as in the  $S_{sm}$  dendrogram. In both dendrograms, *E. clavicornis* var. *nutans* (var. c) links in a way showing Specific rather than Varietal rank. This may be a result of the inefficiency of two-state coding of the attributes. Finally the close grouping of *E. longisepala* with *E. clavicornis* in the  $H_t$  dendrogram is an improvement on their position in the former study.

2. *Comparative tests of the Heterogeneity Functions for Taxonomy using different types of Data:* Using the form of the Heterogeneity function for two-state data that was given in the previous test, the formula for both quantitative and two-state data taken together becomes as follows (c.f. Hall, 1967):

$$H_{tq} = \frac{1}{p} \sum_{i_t=1}^{p_t} \frac{a_{jtr}}{a_{jtrh}} + \frac{1}{p} \sum_{j_q=1}^{p_q} \frac{s_{jqn}}{S_{qnh}}$$

Here, the subscripts  $t$  and  $q$  refer to two-state and quantitative data respectively;  $s_{jqn}$  refers to the standard deviation of an attribute  $j$  for a set of  $n$  members and  $S_{qnh}$  to the value for an imaginary group with the same number of members, together having maximal heterogeneity. For a data maximum of 100, a 3-membered maximally heterogeneous group would have attribute values thus:

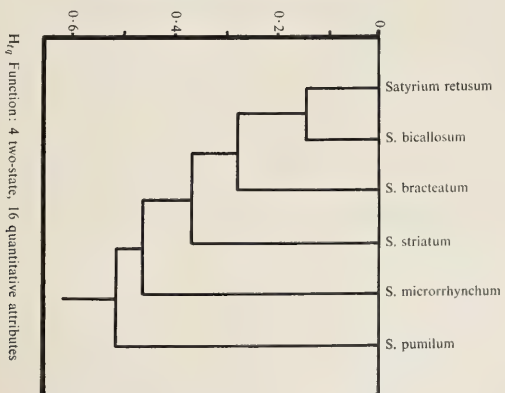
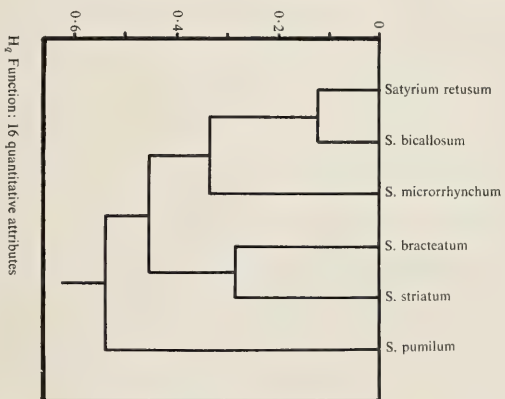
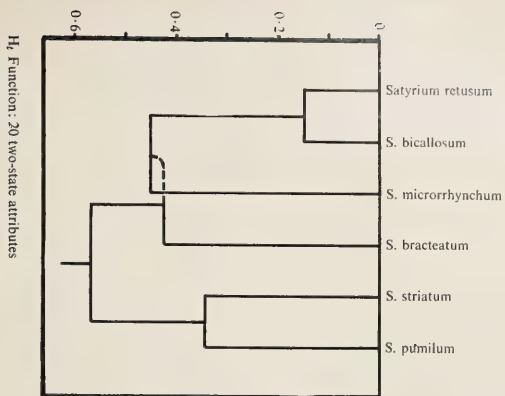


FIG. 4. Dendrograms showing the grouping of six species of *Satyrium* using three different forms of Heterogeneity Analysis.

0 100 100; or thus: 0 0 100. The function for quantitative heterogeneity alone may be given as

$$H_q = \frac{1}{p} \sum_{j=1}^p \frac{s_{jn}}{S_{nh}}$$

Heterogeneity is converted to homogeneity by subtracting the values of  $H_t$ ,  $H_q$ , or  $H_{tq}$  from 1.

For the tests, values for 16 quantitative (measurements and scores) and four two-state (presence/absence) attributes were obtained for six species of *Satyrium* (Orchidaceae). For the test of the quantitative function, the four two-state attributes were omitted. For the two-state function, the 16 quantitative attributes were re-written so that values in one half of the range were coded in one state, those in the other half in the alternative state. The results are shown in Fig. 4. *S. microrrhynchum* and *S. retusum* may be interchanged in the  $H_t$  dendrogram, giving an alternative pathway but identical subsequent structure.

Comparing the dendrograms, the two-state structure, in either of its equally possible forms, is the most different, and departs significantly from expected groupings based on the grounds of personal judgement. Particularly unsatisfactory is the relatively high level of the link of *Satyrium pumilum*, very probably the most peculiar species present, which on occasion has been regarded as belonging to a distinct genus, *Aviceps*. There is probably too little information given by the two-state coding. A better structure is given by the  $H_q$  function with 16 quantitative attributes. Here the position of the lanky, large-leaved and very small-flowered *S. microrrhynchum* seems questionable. The groupings are almost fully satisfactory in the  $H_{tq}$  dendrogram with four two-state and sixteen quantitative attributes. A sub-group formed by *S. bracteatum* and *S. striatum* might just be preferable to the linking one after the other shown in the dendrogram. Perhaps this may occur when other attributes are used in a proposed further study, which will include all taxa in *Satyrium*.

When such a study is made, *S. microrrhynchum* may well appear in another group, such as with *S. parviflorum*, leaving *S. pumilum* at an appropriately isolated level. This possibility illustrates the importance of including all related taxa when investigating category boundaries and optimal arrangements.

3. *Test of Homogeneity Analysis for Vegetation Data*: For comparing plots of vegetation, homogeneity is modulated by a density factor as follows (Hall, 1967):

$$H_{qm} = \sum_{j=1}^p \left( \sum_n a_j \right) \left( \sum_{j=1}^p \sum_n a_j \right)^{-1} \left( 1 - \frac{s_{jqm}}{S_{qnm}} \right)$$

In the unsimplified form of the function, the homogeneity of the  $j$ th of the  $p$  attributes (taxa) is weighted by the average of the abundance values for that attribute for the  $n$  sites, divided by the average of such values for all the attributes. The abundances are all recorded on the same scale with zero representing absence.

Data for the test study were taken from a belt transect in South-West Cape vegetation at Happy Valley, Bains Kloof, near Wellington. The transect passed from river-bank vegetation (plot 16 in Fig. 5) through an intermediate zone (plot 15), across a sandy plain (plots 9–14), up a steepish sandy slope (plots 5–8) followed by a dry, rocky, more gradual slope (plots 1–4). The sixteen  $1\text{ m} \times 4\text{ m}$  plots lie end to end along the transect. The abundances of 54 species on the transect were included in the study.

The need for first grouping the plots, which are in effect samples of vegetation types, into classes was illustrated in the first test attempted. The plots themselves were grouped by homogeneity analysis. All but the last links seemed reasonably appropriate. At the end however, the river-bank and river-bank margin plots (16, 15) took precedence over the four upper slope plots (1–4) in adding to a large cluster formed by the remainder. Plots 15 and 16 clearly carry the more different vegetation, however. The reason for this fallacious result is shown in a more exaggerated case in Fig. 1 of this paper.

A Group Average Linkage dendrogram was therefore prepared for setting the plots into classes, using  $H_{qm}$  values for pair links alone. This is shown in Fig. 5. Five classes are evident: plots 1–4, 5–8, 9–14, 15, 16. In a similar test of the data using the Czekanowski Coefficient (Czekanowski, 1913; Curtis, 1959) the linking sequence was broadly similar. Although the river-bank and river-bank margin plots were well separated from the remainder, other subdivisions were much less distinct, however.

The abundances of each species were then averaged in the plots of each class. A Homogeneity Analysis of this data gave the generally satisfactory dendrogram shown in Fig. 6. Further tests on data from the same area are in hand.

#### PROGRAMS AND COMPUTATION

Computer programs for Heterogeneity Analysis were written in MAC (Manchester AutoCode). The number of instructions needed ranged from about two hundred (two-state function,  $H_t$ ) to 356 (quantitative and two-state function,  $H_{tq}$ ).

After reading in the data, memory stores for the working matrix are set to a large number, half of which are subsequently replaced by a set of heterogeneity values for pair comparisons. Quantitative data are reduced, for each attribute, to a range with a maximum of 1 in the read-in part of the program, so that pair comparisons can be made using the difference of these new values for each

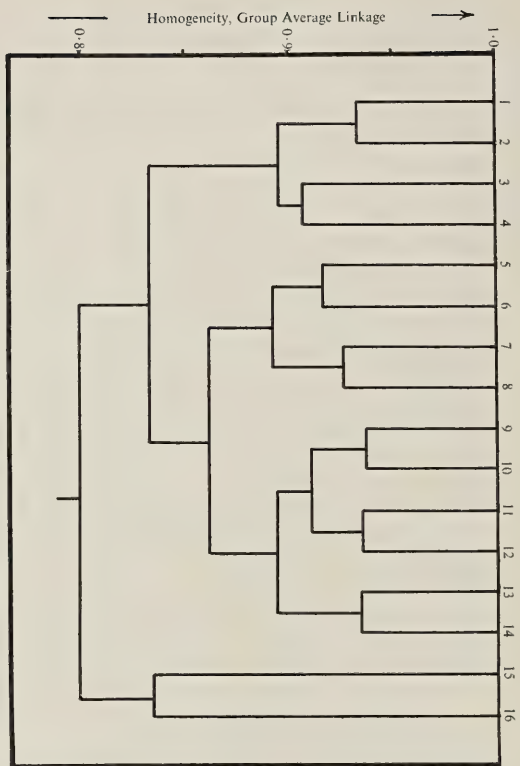


Fig. 5. Dendrogram showing the results of applying the abundance-sensitive Homogeneity Function  $H_q^m$  with pair-comparisons and Group Average Linkage, to data from a belt transect in Cape vegetation.

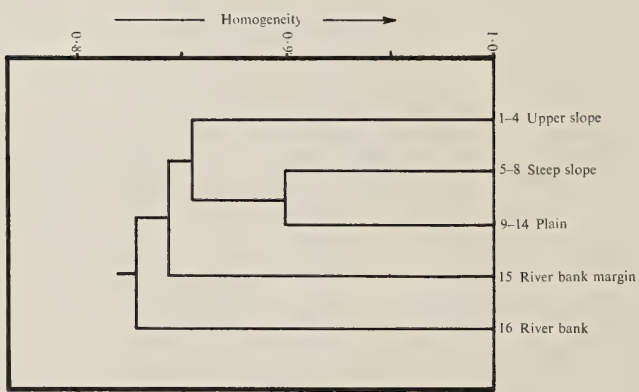


Fig. 6. Dendrogram showing the results of applying Homogeneity Analysis to the classes formed in Figure 5.



attribute, avoiding the standard deviation calculation for the large pair-link matrix. This results in a considerable saving in machine time. The denominator of the standard deviation ratio is also more simply calculated.

After preparing the first matrix of heterogeneity values, the group with the smallest value is found and recorded by the printer. After replacing each of the heterogeneity values relating to the two members linked, by a large number, values are calculated for the trial links of the new group with other members, using in the case of quantitative data the full standard deviation formula. These are again set in the working matrix so that the next minimum heterogeneity case may be determined.

Alternative pathways are detected by the program, and up to any four may be selected by manual control. Alternative pathways, and occasional small reversals, have been found so far only in the tests with two-state data.

Allowance for absence of some of the data about the members has been programmed so far only for the quantitative case, small-scale tests indicating satisfactory results.

Machine times, using the I.C.T. 1301 computer at the University of Cape Town, were within reasonable limits for larger groups. For the program for the two-state function, 40 members described by 93 attributes took 74 minutes 50 seconds; for six members and twenty attributes the time was 56 seconds. For quantitative data, these times would be approximately doubled.

#### CONCLUSIONS

Tests in this study show that, for taxa and vegetation with which the author has had experience, Heterogeneity Analysis provides generally satisfactory groupings. In view of the range of cases that can be accommodated by Heterogeneity Analysis, and its apparent lack of theoretical objections, it would seem to have a promising future. Further testing is needed, especially of the systems for interpreting dendrograms and the application of the method for ecology.

#### ACKNOWLEDGEMENTS

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## THREE NEW SPECIES OF ERICA

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Guthrie and Bolus enumerated 469 species in their treatment of the genus *Erica* in *Flora Capensis* (1905). Since that time a considerable amount of material has been collected in the Cape.

It is inevitable that a certain amount of variation will have been brought to light by these collections. Some of these variations have made a revaluation of the limits of the existing species necessary with the result that a number of them have had to be treated as varieties or subspecies of older species. However, many distinct undescribed species have appeared in these collections and have been dealt with by various authors. Since 1905 some 136 species have been described making a total of 605 species in the genus. There are also a number still requiring to be described from material in the herbaria and there undoubtedly are more that still have to be discovered.

The three species described below are examples of recently discovered ones that have escaped the eyes of the earlier collectors. The illustrations have been prepared for the book *Ericas in Southern Africa* to be published later this year in Cape Town.

***Erica atrovinosa*** E. G. H. Oliver sp. nov.: Section *Ceramus*—*Frutex* erectus. *Rami* erecti, virgati, glabri, dense tecti foliis multis. *Folia* coarctata dispersa, ad 20 mm longa, teretia, tremula, minute setosa, aristata; petiolis 4 mm longis. *Flores* terminales, umbellata vel demum axillares et verticillata; pedunculi ad 17 mm longi; bracteae 3, breves, in medio. *Sepala* ad 3 mm longa, anguste lanceolata, lanceolata vel anguste ovata late base. *Corolla* ad 10 mm longa, globosa-urceolata, glabra, atrovinosa ad atropurpurea; lobis 4 vel 5, latis crenulatis patentibus. *Stamina* 8 ad 10; filamentis lati late sigmoidei apice; antherae dorsales, scabrae, atrobrunneae, appendiculatae; aristis subcristatis, crassis, scabris, decurrentibus. *Ovarium* turbinatum et stipitatum, glabrum; stylo incluso vel manifesto; stigmate capitato vel capitellato.

Erect shrub up to 60 cm (2 ft) high. *Branches* erect, virgate, glabrous, densely

covered with leaves. *Leaves* crowded, scattered, up to 20 mm long, erect to slightly spreading, tremulous, terete, minutely setose, aristate, pale green, shining; petiole up to 4 mm long. *Flowers* terminal, umbellate up to 36-flowered, or becoming axillary and verticillate by growth at the branch apex; peduncles up to 17 mm long, pubescent, red; bracts 3, up to 5 mm long, linear, the lower larger and leaf-like in miniature, pubescent, aristate, red. *Sepals* up to 3 mm long, narrowly lanceolate, lanceolate or narrowly ovate from a broad base which is sometimes toothed, acuminate, sulcate, glabrous or with a few short hairs on the edges and inner surface and with a few sessile glands, greenish-red or red. *Corolla* up to 10 mm long and 7 mm broad, globose-urceolate, glabrous, bright wine-red at the base turning to dark plum-coloured towards the mouth or more or less plum-coloured; lobes 4 or 5, slightly spreading, broad, obtuse, crenulate. *Stamens* 8–10; filaments flat, broadening into a thick cobra-like hood at the apex, glabrous; anthers included, 1–1.5 mm long, attached middorsally, obtuse, scabrid, straight-sided, bilobed at the base, the front lobe longer than the rear lobe, dark red-brown, appendiculate; pore  $\frac{1}{3}$  the length of the cell; awns subcristate, arising from above the middle of the cell, slightly decurrent, straight or spreading,  $\frac{1}{2}$  the length of the cell, thick, dark red-brown and scabrid. *Ovary* up to 4 mm long, narrow turbinate becoming globose-turbinate and ridged on a distinct stipe, glabrous, green; style included or manifest, becoming exserted with age, glabrous; stigma capitate or capitate.

CAPE PROVINCE. Worcester District, between Waaihoek and Mount Superior, 5,000 ft, 24 Jan. 1949, *Esterhuysen* 15119 (BOL, holotype, NBG, PRE). Ceres District, Hex River Mountains, Milner Ridge Peak, 4–5,000 ft, 7 March 1943, *Esterhuysen* 8722; 5–5,500 ft, 26 December 1942, *Esterhuysen* 8463; Shale Peaks, 5,000 ft, 2 Jan. 1955, *Esterhuysen* 24,086; 5,200 ft 22 February 1967, *Esterhuysen* 31,677. Without precise locality, January 1959, *H. F. Wood* s.n.

The first specimens of this species were collected in 1942 by Miss Esterhuysen of the Bolus Herbarium. During her many expeditions to the Hex River Mountain complex she has found plants in only three separate localities at high altitudes. In all three of these localities there are relatively few plants. In the population to which Miss Esterhuysen took the author there were about 30 plants in a small area characterised by the presence of shale in the sandstone formation.

The most striking feature of the plants is the unusual colour combination of bright red and plum in the flowers. The plum colour of the upper half of the corolla is covered by a bloom and darkens with the ageing of the flower. In some cases the plum colour more or less covers the whole corolla and is unique in the genus. The name given to the species, *atro*—dark, *vinosus*—wine-coloured, draws attention to this coloration.

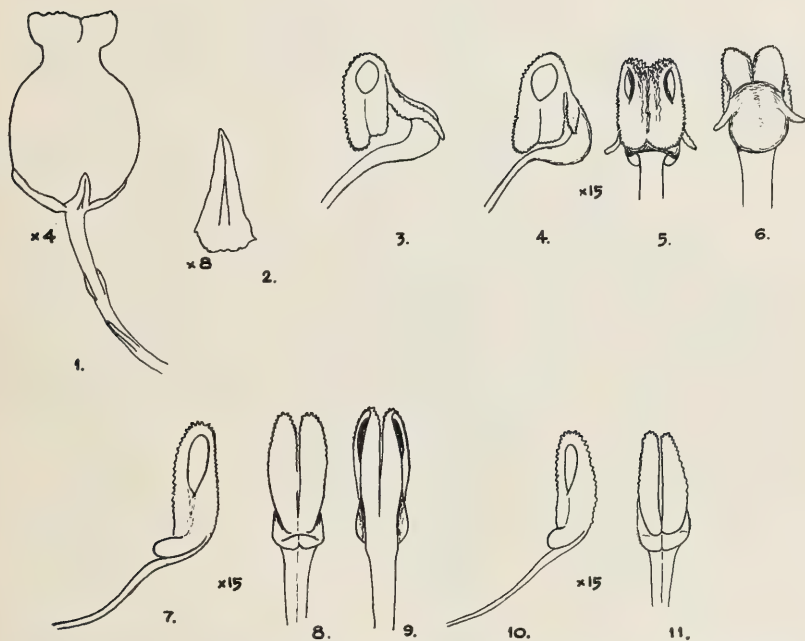


PLATE 1.

1. Flowering branch, nat. size; 2. two flowers showing different corolla shapes ( $\times 3$ ); 3. gynoecium and stamens ( $\times 6$ ); 4. anther, side and back view ( $\times 10$ ); 5. leaf, upper and lower surface ( $\times 3$ ); from a collection on Milner Ridge Peak, Ceres District, February 1967, *Esterhuysen 31,677* (BOL, STE, PRE).







*Erica atrovinosa*; 1. flower; 2. sepal; 3, 4, 5 & 6. anther, two side, front and back views; from Esterhuysen 31677.—*Erica gossypioides*; 7, 8 & 9. anther, side, front and back view; from Esterhuysen 30, 657; 10 & 11, side and front view; from Stokoe 8564.

In the wild state the plants are not very striking from a distance, even though they might be in full bloom, due to the very dark colour of the flowers. So much so that it is difficult to believe that the plants are bearing fresh flowers.

Another distinctive feature about the species is the long shimmering leaves which are crowded together on the branches. This immediately calls to mind the same type of leaf found in *Erica vestita* Thunb. The versatile nature of the leaves is produced by the long thin petioles.

*E. atrovinosa* is a distinct species but bears a number of characters in common with *Erica inflata* Thunb. It differs from the latter in having a less bushy habit, more crowded leaves which are terete and tremulous and anthers with large pouched filaments and dark thick scabrid awns. The filaments in *E. inflata* are thin and narrow below the anther and the awns are long, thin and pale.

***Erica gossypoides*** E. G. H. Oliver sp. nov.: Section *Gamochlamys*—Species nova et bene distincta, omnibus partibus lanatissimis, corolla glabra et cyathiformis antheris prognathis basi notabilis. *Frutex* erectus. *Rami* multi, erecti, lanati. *Folia* 4—nata ad 6 mm longa, lineares ad lanceolata, sulcata, lanata. *Flores* terminales 2— ad 5—nati, cernui; pedunculi ad 9 mm longi, lanati; bracteae 3, basales, breves, lanatae. *Sepala* ad 4 mm longa et 2 mm lata, elliptica ad anguste obovata, dense lanata. *Corolla* ad 6 mm longa et 5 mm lata, cyathiformis, glabra, rosea rubescens; lobis latis obtusis. *Stamina* 8; filamenta breves aequilonga antheris; antherae inclusae, 2 mm longae, prognathae basi, scabrae. muticae; poro  $\frac{1}{4}$ — $\frac{1}{3}$  pars longitudinis lobi. *Ovarium* globosum, 2 mm longum, lanatum superne; stylo incluso; stigmatibus capitellato.

A new and distinct species characterised by all parts being very lanate, by a glabrous cyathiform corolla and anthers prognathous at the base.

Erect shrublets up to 45 cm ( $1\frac{1}{2}$  ft). *Branches* many, ascending, lanate. *Leaves* 4-nate, up to 6 mm long, linear to lanceolate, sulcate, obtuse, lanate on outer surface, glabrous on inner surface; petiole 1 mm long. *Flowers* terminal, 2- to 5—nate, cernuous; peduncles up to 9 mm long, lanate; bracts 3, basal, 2 mm long, middle one shorter, narrowly obcuneate, lanate on the margins. *Sepals* up to 4 mm long and 2 mm wide, elliptic to narrowly obovate, acute, slightly keel-tipped otherwise flat, densely lanate on the outside, villous on the inside. *Corolla* up to 6 mm long and 5 mm wide, cyathiform, glabrous, pink turning red; lobes very broad, obtuse, rounded. *Stamens* 8, included; filaments short reaching to the top of the ovary, as long as or just longer than the anthers, glabrous, flat; anthers 2 mm long, straight-sided, obtuse, prognathous at the base, dark brown, scabrid, muticous; pore  $\frac{1}{4}$ — $\frac{1}{3}$  the length of the cell. *Ovary* globose, 2 mm long, lanate on the upper half, glabrous on the lower; style short, included glabrous; stigma capitellate.

CAPE PROVINCE. Ladismith District, Klein Swartberg, Thursday Peak, shale



PLATE 2.

1. Flowering branch, nat. size; 2. leaf, lower and upper surface ( $\times 4$ ); 3. gynoecium and stamens ( $\times 3$ ); 4. anther, back view ( $\times 4$ ); from the type collection on Thursday Peak, Klein Swartberg, Ladismith District, March 1964, *Esterhuysen* 30,657 (BOL, STE, PRE).





band below cliffs, 6,500 ft, 28 March 1964, *Esterhuysen* 30657 (BOL, holotype, K, PRE, BM, STE, NBG); Hoekoe Peak, 6–6,500 ft, 29 March 1959, *Esterhuysen* 28265 (BOL). Prince Albert District, Swartberg above Klippies Vlei, December 1942, *Stokoe* 8564 (BOL).

*E. gossypioides* was first collected by that veteran collector, T. P. Stokoe, on the Great Swartberg in 1942. He gave the locality as "above Klippies Vlei". This obviously refers to the forestry area, Kliphuis Vlei, which is just west of the top of the Swartberg Pass, Prince Albert District. Very few collectors have been to this mountain range in recent years with the result that there are no further records of this species in the area. The author has visited the Kliphuis Vlei locality on several occasions without locating the species. However, the locality, "above Klippies Vlei" covers a vast area and it is thus not surprising that the species could not be located.

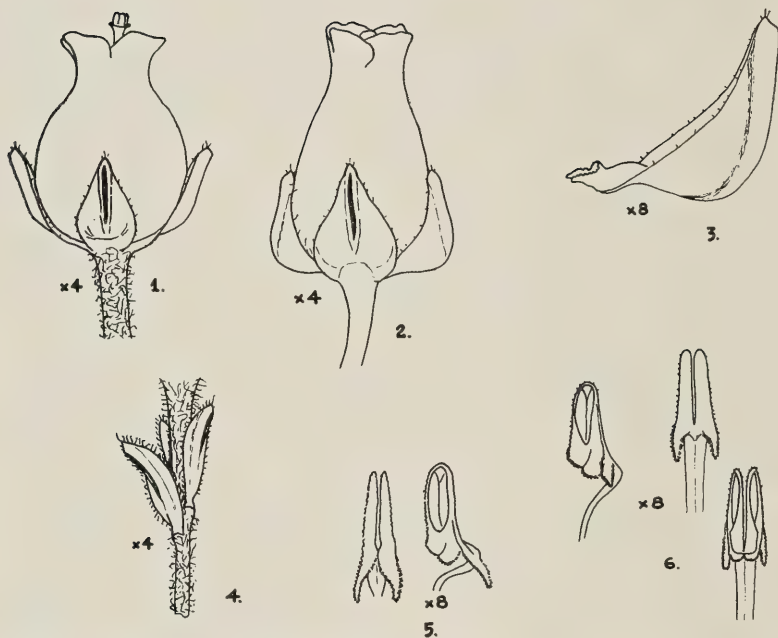
Fortunately Miss Esterhuysen turned the species up in two separate localities 50 miles due west on the same range where it is referred to as the Klein Swartberg. Both populations were between Toverkop and Seven Weeks Poort at high altitudes, 5,000 to 6,500 ft, where the plants are covered by snow every winter. The plants were not common in either area.

The most striking feature of *E. gossypioides* is the extreme woolliness of most parts of the plant. The woolliness of the calyx is like that of a piece of cotton-wool, hence the name of the species. In the genus *Gossypium* the fruiting heads are white-woolly. In the erica the flowers are reminiscent of this in miniature.

The delicate pink colour of the corolla which shows through the woolliness of the calyx soon turns dark red on ageing. When the corolla has closed up, only a small point of red remains projecting beyond the white calyx.

The affinities of *E. gossypioides* are with *E. passerinae* Montin in section *Gamochlamys* and to a lesser extent with *E. trachysantha* Bolus in section *Melastemon*.

It is allied in having a cyathiform, glabrous corolla and basal bracts. It does not however have the characteristic feature of *Melastemon*—a flattened crest above the pore of the anther. It is unlike *E. passerinae* in not having the calyx fused at the base. The inflorescence in these two sections is pseudo-axillary with flowers borne up the stem on very short lateral branchlets. In *E. gossypioides* the flowers are strictly capitate in terminal heads. In this respect the species resembles members of the section *Eriodesmia*. The woolliness of the calyx is characteristic of this latter section. The only character which excludes the species from *Eriodesmia* is the glabrous cyathiform corolla. It is probably best to regard *E. gossypioides* as belonging to the section *Gamochlamys*.



*Erica calcareophila*; 1 & 2 two different shapes of flower; 3. sepal, side view; 4. peduncle and bracts; 5. anther with large appendages; 6. anther with small appendages all from STE 30, 159.

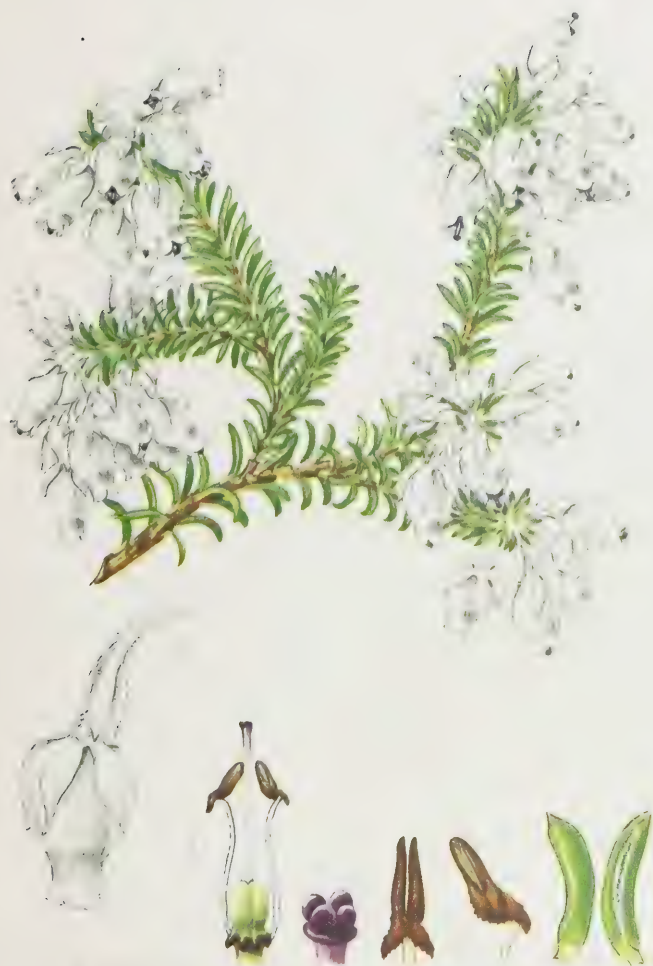


PLATE 3.

1. Flowering branch, nat. size; 2. flower ( $\times 2$ ); 3. gynoecium and stamens ( $\times 3$ ); 4. stigma ( $\times 12$ ); 5. anther, back and side views ( $\times 8$ ); 6. leaf, upper and lower surface ( $\times 2$ ); from the type collection near Hagelkraal, Bredasdorp District, August 1966, *Oliver* in STE 30,159 (STE, BOL, PRE).



Due to circumstances fresh material could not be obtained for the painting for the book. The plate included here is adapted from a painting by Fay Anderson of the type material and the dissections are from the herbarium material.

***Erica calcareophila*** E. G. H. Oliver sp. nov.: Section *Eurystegia*.—*Fruticulus* prostratus vel semiprostratus ad 15 cm (6 ins) altus. *Rami* pauci plani insidens saxis, tecti multis cinereis cicatibus ubi veteres, aliter foliacei. *Folia* 4—nata ad 13 mm longa, patentes, recurvata, minute mucronata, dense ciliata vel glabra marginibus. *Flores* 1— ad 6—nata, terminales, fasciculati versus fines ramorum; pedunculi ad 15 mm longi, dense ciliati; bractae 4—7 mm longae, remotae. *Sepala* 5—7 mm longa, 3—4 mm lata, ovata, glabra, ciliata marginibus, distincte L-formis, valde sulcata. *Corolla* 9—11 mm longa, 5—8 mm lata, globosa-urceolata, glabra, lactea; lobis erectis vel leviter patentibus, obtusis. *Stamina* 8; antherae inclusae, 2·5 mm longae, laterales, scabrae, appendiculatae; aristis rectis. *Ovarium* globosum glabrum; stylo manifesto; stigmatibus capitato, 4-lobato.

Prostrate or semiprostrate shrublet up to 15 cm (6 ins) high. *Branches* few, flat on rocks, gnarled, covered with numerous grey leaf-scars when old, otherwise leafy, occasionally pubescent when young. *Leaves* 4—nate, up to 13 mm long, recurved, spreading, minutely mucronate, densely ciliate-edged or glabrous, rounded, hard in texture. *Flowers* 1— to 6—nate, terminal, clustered at ends of branches, sometimes in dense heads; peduncles up to 15 mm long, densely ciliate, white or reddish; bracts 4—7 mm long, remote, like the sepals but smaller. *Sepals* 5—7 mm long, 3—4 mm broad, ovate, glabrous, ciliate-edged with a few sessile glands intermixed, distinctly L-shaped, strongly keeled, hollowed inside with edges rolled back at the base, white. *Corolla* 9—11 mm long, 5—8 mm broad, globose-urceolate, contracted below the throat, glabrous, wax-like, white; lobes erect or slightly spreading, obtuse. *Stamens* 8; anthers 2·5 mm long, lateral, deeply lobed, roughly scabrid, appendiculate; pore  $\frac{1}{2}$ — $\frac{2}{3}$  the length of the cell; awns elongate-cuneate, straight or slightly incurved, scabrid-edged. *Ovary* globose, glabrous; style manifest becoming exerted on ageing; stigma 4-fid, appearing capitate when young.

CAPE PROVINCE. Bredasdorp District, Hagelkraal, on limestone hills, locally frequent, August 1966, *Oliver* in STE 30,159 (STE, holotype, BOL, PRE, NBG, K, BM); Pearly Beach, limestone hills, August 1966, *Oliver* in STE 30,169 (STE).

In many characters this species resembles *E. propinqua* Guthrie and Bolus and *E. excavata* L. Bolus. The most striking difference is in the habit of the plants. The latter two species are erect whereas *E. calcareophila* forms prostrate or semiprostrate shrublets often only a few inches high, gnarled and spreading. However, in a few sheltered corners longer branches are formed but apparently never form erect shrublets as the branches tend to lie against the rocks. In the



area where *E. calcareophila* was collected, *E. propinqua* was growing but on the open slopes as erect shrubs.

Structurally there are three differences. In *E. excavata* and *E. propinqua* the flowers tend to be borne singly in elongate pseudospikes. In *E. calcareophila* the flowers tend to form terminal heads, never elongate pseudospikes. The leaves of *E. calcareophila* are recurved, in some cases only slightly and others markedly so, whereas in the other two species the leaves are straight. There is considerable variation in the leaves of *E. calcareophila*. In the line drawing the most markedly recurved leaves are shown. The awns in *E. calcareophila* are straight unlike the curved, laterally spreading awns in the other two species.

There is some doubt as to the distinctness of *E. propinqua* and *E. excavata* as separate taxa at specific level. The latter could be just a large-flowered form of the commoner *E. propinqua*.

*E. calcareophila* appears to be very localised on the chain of limestone hills between Pearly Beach and Quoin Point, Bredasdorp District, where it is confined to rocky ledges and boulder-strewn slopes. In one locality at Hagelkraal the plants were locally frequent on large boulders that had broken off the limestone cliffs. All the plants seen were growing on rock or in crevices, none was growing on the open ground.

#### ACKNOWLEDGMENTS

The author wishes to acknowledge the loan of the colour plates by the Chief, Botanical Research Institute, Pretoria, the use of the colour blocks paid for by the Trustees of the Erica Book Fund and especially the help of Miss E. Esterhuysen of the Bolus Herbarium in obtaining specimens.

In the book *Ericas in Southern Africa* due to be published later this year, name changes made by Dr. H. Dulfer in Ann. Naturhist. Mus. Wien (1965) have been adopted. However one species included in the book was incorrectly treated by Dulfer. It is thus necessary for the correct combination to be made valid prior to the publication of the book.

Two species of *Erica*, *E. grandiflora* L.f. and *E. exsurgens* Andr., were treated as separate species by Guthrie and Bolus in Flora Capensis 4: 57 (1905). Recent investigations of the material show that the two taxa cannot be upheld at specific level and must be treated at varietal level. The following combinations are thus necessary.

***Erica grandiflora* L.f.**, Suppl. 223 (1781); Guthrie and Bolus in Fl. Cap. 4: 57 (1905); *E. exsurgens* var. *grandiflora* (L.f.) Dulfer in Ann. Naturhist. Mus. Wien 68: 35 (1965).

***Erica grandiflora* var. *exsurgens* (Andr.) E. G. H. Oliver** stat. nov. *E. exsurgens* Andr., Col. Heaths t. 22 (1796); Guthrie and Bolus in Fl. Cap. 4: 57 (1905); Dulfer in Ann. Naturhist. Mus. Wien 68: 35 (1965).

# STUDIES IN THE XYLARIACEAE: I. NEW AND OLD CONCEPTS\*

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## INTRODUCTION

The Xylariaceae have long been regarded as one of the most specialized groups of the Ascomycetes. Their large size, great variety of form and colour, and a relatively high level of differentiation are matched by few other families, and indeed make them unique among the Fungi.

Winter (1887) established the family to include all the Pyrenomycetes with predominantly dark stromata and dark unicelled spores, a concept subsequently embodied in important work by Miller (1928*a*, 1928*b*) and Dennis (1956, 1957). A different idea of the family was put forward by von Arx and Müller (1954, pp. 135 and 276) when they distinguished it on microscopical features alone, comprising club-shaped or cylindrical unituminate asci, each containing a complex apical structure, and dark unicelled spores with germ pores or germ slits. In the writer's view this is too drastic a revision because of the inclusion of many non-stromatic genera which possess various complexities of their own and do not figure in the anatomic specialization of the stromatic members. The writer, however, accepts that the detailed characters of von Arx and Müller in conjunction with the stromal features outlined by the earlier authors do provide a reasonable basis for definition of the Xylariaceae.

Identification of the various genera has been often fraught with a similar clash of opposing concepts. Recognition of an appropriate system of classification has been slow, mainly because the early workers of the nineteenth century gave undue emphasis to obvious but rather variable characters such as external form and colouration. Part of the problem consists of determining which are the most useful characters and which should most easily be discarded.

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The classical features employed in classification are:

- (1) Colour, size and shape of stroma;
- (2) Depth to which the stroma is sunken in the substrate, and whether superficial or erumpent;
- (3) Number and shape of perithecia;
- (4) Spore size and colouration; less frequently, spore shape.

The writer believes that these characters are useful in conjunction but not when taken singly. Furthermore, they have been used to the almost complete exclusion of several other characters which are as reliable if not more so. However, the latter require microscopic investigation and are often hard to determine. Another factor that is poorly understood is the relative importance that should be attached to each character. They may be divided into two categories:

- (1) Those which show a degree of correlation with a set of several other characters, and are present in a large number of the taxonomic variants. The value of these characters increases according to the completeness of the correlation and it is on these that genera are customarily founded because they usually express a single "idea" or theme. Much of the confusion in taxonomy is caused by the occurrence of two or more dominant features associated with overlapping sets of subordinates, on the relative value of which the investigator has to make a subjective judgement.
- (2) Those which are absolutely correlated with certain character groups and do not occur elsewhere, but whose frequency is not absolute. It is these which are hard to evaluate. When present in the majority of species of a taxon the writer is inclined to recognize it as of major importance; when only in a minority, however, its value is questionable.

No key to the currently accepted genera of the entire Xylariaceae has yet been written, but the following key, synthesized from the analytical work of von Arx & Müller (1954), Dennis (1957, p. 305), Hennings (1902, p. 16), Lloyd (1919), Miller (1928*b*, p. 336; 1942, p. 250; 1961, pp. 132-143) and Traverso (1906, pp. 21, 40, 57, 169, 173, 449, 475) is based on the criteria customarily used. Genera synonymous with these here, but discarded due to lesser priority, will be discussed in later papers.

A. Perithecia single or aggregated

I. Superficial

- a. Without protuberances
- aa. With conical protuberances

*Rosellinia* De Notaris (1844)  
*Stilbohypoxyton* Hennings  
 (1902)

II. Sunken in the substrate

- a. Valsoid
- aa. Dispersed or effuse

*Anthostoma* } *Lopadostoma* (Nitschke)  
 Nitschke (1867) } Traverso (1906)  
                               } *Anthostomella* Saccardo  
                               (1878, 1882)

- B. Perithecia several to many in the stroma
- I. Perithecia at the base of the stroma, with more or less elongated necks
- a. Perithecia polystichous *Bolinia* Nitschke (1867)
- aa. Perithecia monostichous
- i. Perithecia elongate
- j. Stroma aplanate *Camarops* Karsten (1873)
- jj. Stroma cylindric *Camillea* Fries (1849)
- ii. Perithecia ovate or oval
- j. Stroma effuse, perithecia very large *Theissenia* Maublanc (1914)
- jj. Stroma cupulate or effuso-convex *Nummularia* Tulasne (1863; Nomen invalidum) syn. *Numulariola* House (1925)
- jjj. Stroma effuse repand, with subcoriaceous peridium *Peridoxylon* Shear (1923)
- II. Perithecia seated at the periphery of the stroma, monostichous or occasionally polystichous
- a. Ostioles absent or obsolescent *Phylacia* Léveillé (1845)
- aa. Ostioles present
- i. Stroma variously shaped but not stipitate
- j. Stroma light coloured, inside gelatinous and hollow *Entonaema* Möller (1901) syn. *Sarcoxydon* Cooke (1883)
- jj. Stroma light, inside fleshy *Penzigia* Saccardo (1888, 1892)
- jjj. Stroma dark, inside corky
- k. Interior concolorous *Hypoxylon* Bulliard (1791)
- kk. Interior zonate *Daldinia* Cesati & De Notaris (1863)
- ii. Stroma broadly clavate to filiform or capitate, simple or branched, definitely stipitate
- j. Sterile portion of stroma formed of strands, fertile portion clavate *Thamnomycetes* Ehrenberg (1820)
- jj. Sterile portion of stroma not formed of strands
- k. Fertile stroma capitate, forming an expanded disc in which the perithecia are uniformly distributed
- l. Caespitose, on wood *Kretzschmaria* Fries (1849)
- ll. Not caespitose, on dung *Poronia* Gleditsch ex Wildenow (1787)
- kk. Fertile stroma clavate or filiform
- l. Occurring on wood *Xylaria* Hill ex Fr. (1751)
- ll. Occurring on dung *Podosordaria* Ellis & Holway (1897)

It is the object of this and succeeding papers to supplement this classification and to amend it where necessary, giving the most weight to those sets of features which show the maximum degree of intra-correlation and which also show the least variability.

#### MATERIALS AND METHODS

Herbarium and fresh material were investigated according to standard methods, and precise descriptions drawn up for each specimen. Damaged or very old material was rejected. Out of 1550 collected specimens the writer succeeded in culturing some 600 on 2% malt agar and then recording the gross characteristic of the colonies and those of the imperfect stage where formed.



The linear growth rate of colonies in plate culture at 25° was also determined according to the method of Brancato and Golding (1953). Whereas an adequate amount of material of the perfect stage was examined for each genus, it was unfortunately not possible to obtain as complete a representation of the cultural characters due either to the age of the specimen when collected in the field or to some innate peculiarity which prevented ready germination.

## RESULTS

The following is an attempt to evaluate old and new characters as a result of this research.

### A. Characters of the perfect stage.

1. *Geographic distribution.* The Xylariaceae are ubiquitous in distribution yet the family shows its greatest specialization of form in the tropics to which the genera *Kretzschmaria*, *Phylacia*, *Camillea* and *Thamnomycetes* are restricted. Although there have been abundant collections made of the tropical species, most of our knowledge of the family stems from the more intensive work done on the European and North American ones by mycologists resident in those countries. More information will probably reveal fairly clear cut differences in generic distribution which are at present too scanty to be used in classification. Many of the species may also be based primarily on differences in latitude of origin. For example, *Hypoxylon rubrostromaticum* Miller is the tropical counterpart of the northern *H. fuscum* Pers ex Fr. The two species show only minor differences in the perfect stages and could easily be confused, but the writer has found that *H. rubrostromaticum* grows faster and has a temperature tolerance of up to 33°C instead of 28°C, a factor which could have definite significance when further information is obtained on its tropical range.

Most of the Xylariaceae are inhabitants of wooded regions, but the range of the environment extends from mesic to semi-arid. *Xylaria fioriana* Sacc. has been found by the writer in South Africa in open scrub where the rainfall is less than 15 inches per annum. On the other hand the writer has also always found *Hypoxylon murcidum* B. and Br. in South Africa and in North America close to running water. Much more needs to be found out about the water requirements and physiology of these fungi before these can be incorporated in their taxonomy, and the problem is made more difficult in that it has been impossible up to now to rear stromata in culture.

2. *Substrate.* The vast majority of the species grows on dead wood but a significant few prefer nonlignaceous materials including earth, dung, dead leaves and fruit rind. This is interesting since it is correlated with lack of rigidity in the stroma and a lesser degree of differentiation (*Poronia*, *Podosordaria*). Otherwise, substrate differences have not been found important.



3. *Species host preference.* Species preference was found to be important in some cases but not above the specific level. The reason why some species are only found on certain trees is hard to determine. Some examples of this sort of specialization are:

SPECIES	HOST
<i>Hypoxylon sassafras</i>	<i>Umbellularia californica</i>
	<i>Sassafras</i> spp. and other Lauraceae
<i>Hypoxylon laurus</i>	<i>Gleditschia triacanthos</i>
<i>Hypoxylon grandineum</i>	<i>Quercus</i> spp.
<i>Hypoxylon tinctor</i>	<i>Platanus occidentale</i>
<i>Hypoxylon murcidum</i>	<i>Olea capensis</i>
<i>Xylaria fioriana</i>	<i>Aloe ferox</i>

4. *Shape of the stroma.* This is one of the most difficult of all the characters to evaluate. The shape may vary with the number of the perithecia per stroma—when uniperitheciate, the stroma will be globose or ovoid; when containing two or several perithecia, pulvinate or aplanopulvinate; and when multiperitheciate, usually aplanopulvinate, globose, or hemispheric. Thus the number of perithecia per stroma is a rather important character when it influences size. The writer, having seen the extent of variation within samples, is of the opinion that the *potential development* within a given range of variation is sometimes more important as a basis for making categories than the most commonly assumed state. Such factors are however bound to be subjectively treated in considering the limits of genera and species, for some some species appear to be characterized by uniperitheciate stromata and others by multiperitheciate, while in general the majority show both types. Even though only a relatively small number of specimens has been examined, however, it has been found difficult to support the traditional separation of *Rosellinia* from *Hypoxylon* based purely on perithecial number.

5. *Size relationships of the stroma.* The same remarks apply to these as to the stromal shape, since they are intimately related. The family contains two extremes, one where the stroma is much wider than high and another where height is dominant. Between them lie a group of intermediates with which other characters are also correlated. No longer is it satisfactory to call species with elongate stromata "*Xylaria*" and the aplanate ones "*Hypoxylon*"; the position of many species can only be estimated by the juggling of many other characters in addition.

6. *Branching of the stroma.* This character is restricted to *Thamnomycetes*, *Kretzschmaria*, *Xylaria*, *Poronia* and *Podosordaria*. It has been a source of confusion for two reasons: first, because there are so many species in which it is variable, and second, because the fertile clavulae which the branches bear are in most cases directly comparable to the clavata of related unbranched species, i.e., the effect of branching does not materially influence morphology.

Hence it is debatable whether a branched stroma often differs significantly from an unbranched one for taxonomic purposes. Should the complex branching to the second or an indefinite degree on which the genus *Kretzschmaria* is based be regarded as sufficient to separate it from *Xylaria*, where the stroma is unbranched or branched to the first degree? Clearly we have a problem similar to that of perithecial number, and there is no ready objective method of evaluation.

7. *Fertility of the stroma.* Many of the Xylariaceae exhibit sterility of part of the stroma in their particular trend of specialization. In the aplanate stromata of *Hypoxyton* various areas in between the perithecia may be sterile, while the cylindric ones of *Kretzschmaria* and *Xylaria* develop stipes or slender apices. These characters are chiefly valuable at specific level only, yet have been used to delimit sections in the genus *Xylaria* (Fries, 1851).

8. *Subiculum.* This has been neglected almost totally. It is found in *Rosellinia*, *Penzigia*, *Kretzschmaria* and *Xylaria*. Basically the subiculum consists of any extrastromal mycelium not incorporated into the fertile portion. It is bright or dark coloured, crustose or matted, and contains five distinct branching types:

- (1) loose: sparingly branched and infrequently anastomosed; (Plate I:1)
- (2) ropy: sparingly or frequently branched, infrequently anastomosed but with several contiguous hyphae lying parallel and forming long cords; (Plate I:2)
- (3) reticulate: frequently branched but loosely anastomosed to form a net-like system; (Plate I:3)
- (4) close: frequently branched and clearly anastomosed to form a pseudo-parenchymatous mass (Plate I:5 and 6)
- (5) tentacular: similar to (3) but with short prong-shaped branches usually projecting; (Plate I:4)

This type has only been found in nature in association with *H. cantareirensis*.

The subiculum is interesting because its association with stromata of low specialization (*Rosellinia*) and with high specialization (*Kretzschmaria*, *Penzigia*, *Xylaria*) may indicate a line of direct development between the two. The stromatic construction of these genera has several points in common, the chief being the carbonaceous outer layer and the light coloured soft tissue beneath the perithecia and the general absence of colouration prevalent in the other genera. The various types of subiculum are distributed equally and so cannot be used to differentiate any genus or species group as a whole, but they are clearly of supplementary value as specific characters.

9. *The differentiation of the stroma.* This subject has been poorly under-

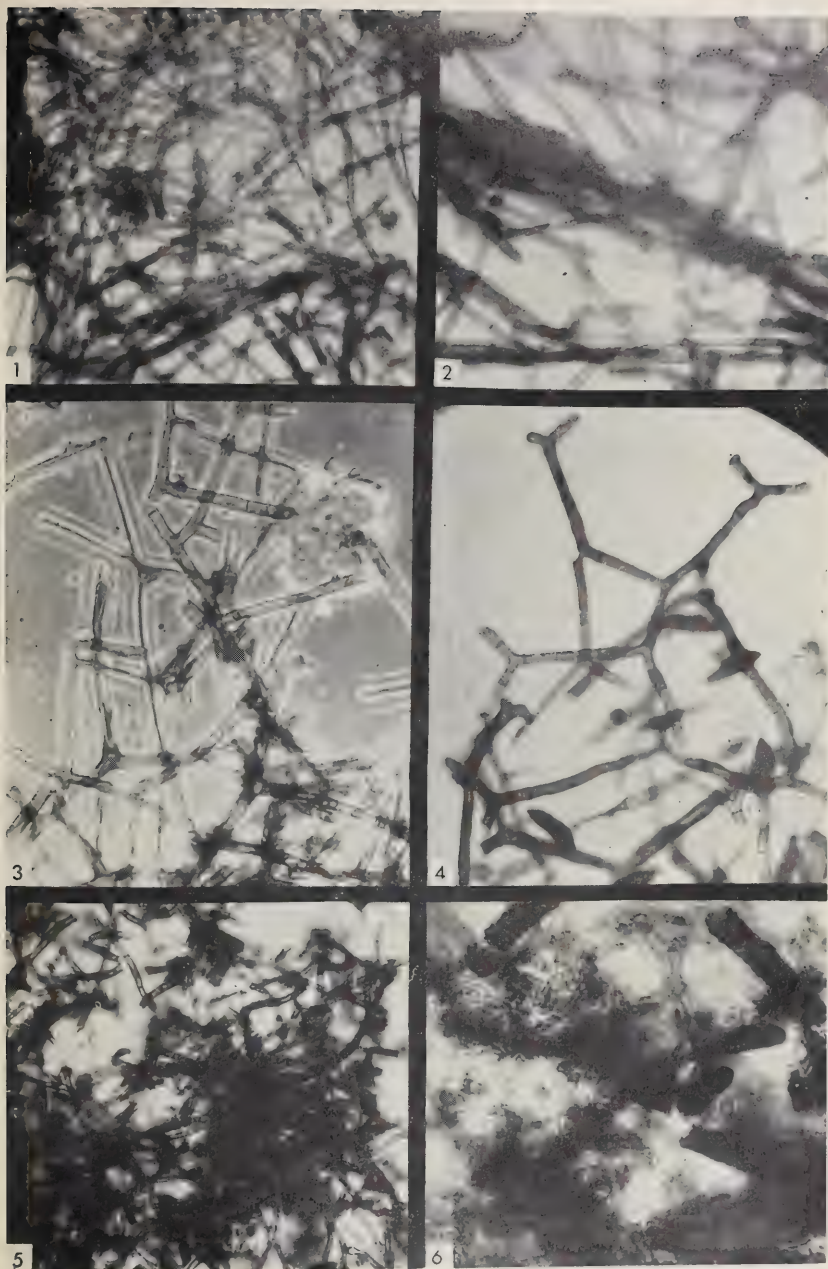
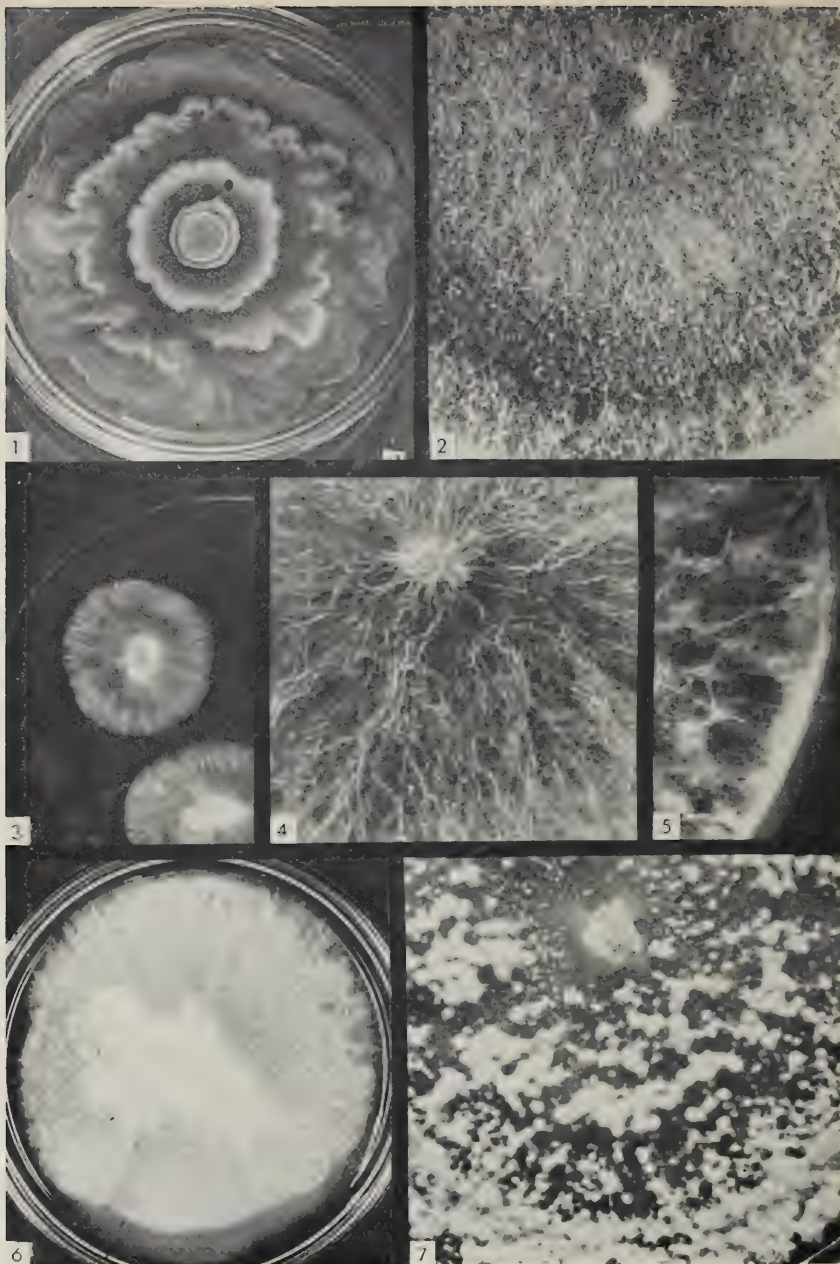


PLATE I.  
Types of Subiculum in the Xylariaceae.

1. Loose and separable: *Xylaria euglossa*.  $\times 470$ .
2. Ropy: *Hypoxylon pulcherrimum* (*Rosellinia pulcherrima*).  $\times 470$ .
3. Reticulate: *Hypoxylon aquilum* (*Rosellinia aquila*).  $\times 470$ .
4. Reticulate-tentacular: *Hypoxylon cantareirens*.  $\times 470$ .
- 5 and 6. Closely anastomosed: *Hypoxylon corticium* (*Rosellinia corticia*).  $\times 280$ .





# PLATE II.

## Types of Colony in the Xylariaceae. I.

1. *Hypoxylon smilacicum*: zonate colony grading from submersed through canescent to appressed felty.
2. *Hypoxylon multifforme*: coarse felty type.
3. *Hypoxylon albocinctum*: young velvet colonies.
4. *Numulariola (Hypoxylon) tinctor*: cottony type with straggling hyphae.
5. *Numulariola mediterranea (Hypoxylon mediterraneum)*: cottony type with vertical tufts.
6. *Hypoxylon adumbratio* nov. sp.: gradation from velvety to lanose at centre.
7. *Xylaria cubensis*: floccose type.

stood. Dennis (1956, 1957), whose work provides some of the clearest illustrations of the Xylariaceae, still makes only brief mention of the types of tissue that occur. Miller (1928a) has partially analyzed the stromal layers in *Hypoxylon* and its close relatives but completely fails to homologise them with those of *Xylaria*.

Two separate layers of the stroma were clearly recognized by him:

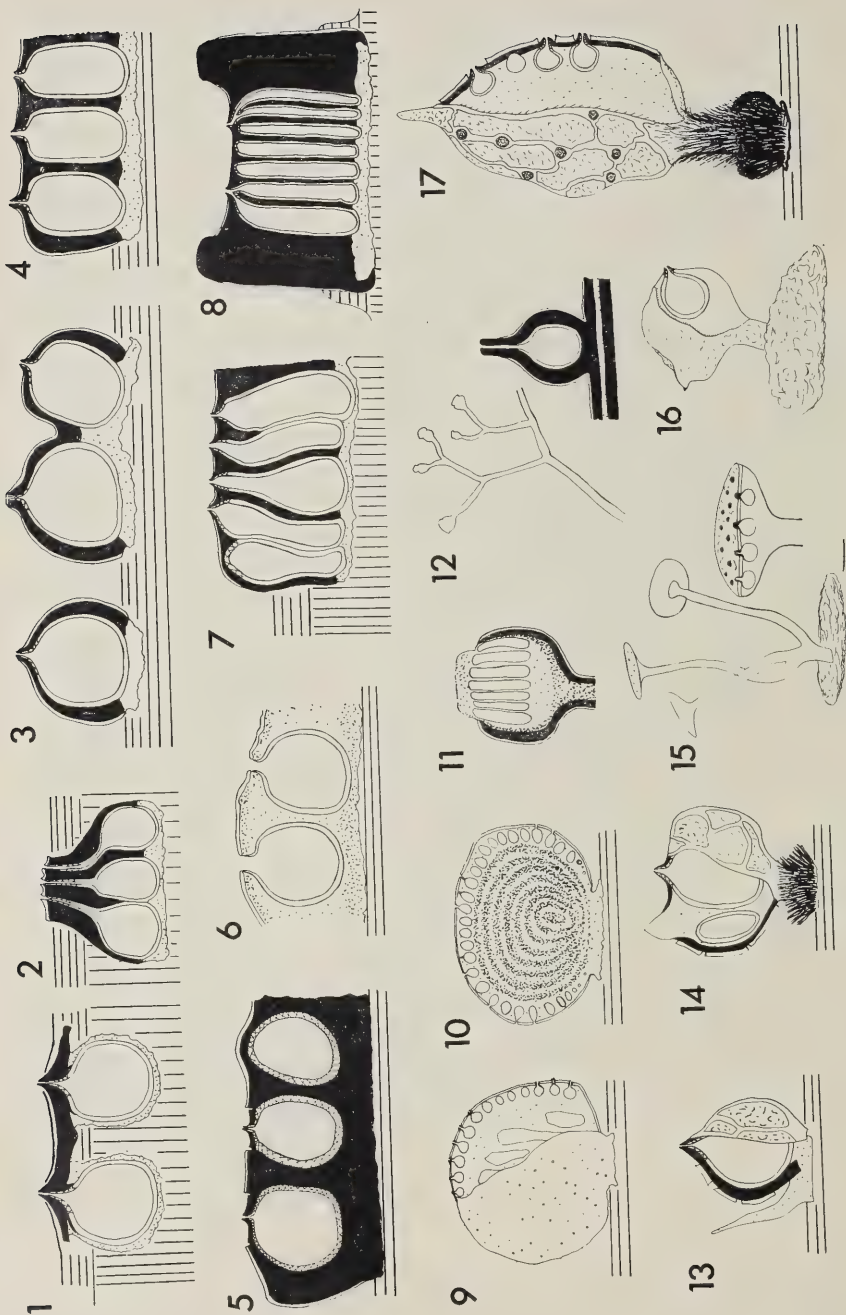
- (1) the "ectostroma" which is "that part of the stroma first formed in or on the periderm or on the bark when the wood has been removed, and functions in rupturing the bark when the latter is present; and which normally functions in producing the conidia", and
- (2) the "entostroma" which is "that portion of the stroma that develops under the ectostroma and bears the perithecia in its periphery". Miller's emendation of the genus *Hypoxylon* was based on the appearance and relative proportions of these two structures as defined.

In actual fact, while the conclusions drawn were mainly correct, he failed to recognize that there are actually *four* potential stromal layers each of which has useful taxonomic characters, and not all four are necessarily present together. Only the obscure tropical genera, *Phylacia* and *Thamnomycetes*, possess them all and give the clue to the correct homology of those remaining when one or more of those layers are absent. They comprise:

- (1) an outer veneer, usually coloured, that may be continuous, worn off irregularly, or remaining granulate;
- (2) an outer layer which is pale or coloured initially, and remains such or turns darker. This may be corky and persistent (as in *Xylaria*) or be composed of a brittle refractive coloured material (as in *Hypoxylon* section *Euhypoxylon*, and in *Phylacia*) that breaks up into small granules under microscopic examination. Initially it is continuous but later it may break up in a variety of characteristic ways, each one of specific value. This is the ectostroma, as the writer understands it, and is independent of conidial formation. It is not always developed, in which case the next layer becomes the outer one of the stroma;
- (3) a layer which is dark coloured, usually black and rigid, including deposits of carbonaceous material. It covers the perithecia or may enclose them as well;
- (4) an inner core, termed here as basal tissue, which is rarely carbonaceous, and is normally soft. This has been termed "fleshy" by most authors; the writer finds that this tissue varies in solidity, and the term "corky" is preferable when it is feebly resistant to the point of a needle. In colour it varies from white to dull brown or grey.

The two latter tissues form the structure known as the *entostroma*. No





separation occurs between them, and sectioning reveals continuity of tissue. On the other hand, layer (2) quite frequently separates from those underlying.

The double usage of the term "ectostroma" has resulted because layers (2) and (3) were considered identical. The nature of each layer is highly important generically, and their distribution for each genus is summarized in the following table. (See also Fig. I.)

LAYER	GENUS
1	<i>Hypoxylon</i> , sections <i>Annulata</i> and <i>Euhypoxylon</i> <i>Daldinia</i> <i>Phylacia</i> <i>Thamnomycetes</i>
2	All genera except <i>Podosordaria</i>
3	All genera except <i>Poronia</i> and <i>Podosordaria</i> , and <i>Hypoxylon</i> section <i>Euhypoxylon</i>
4	All genera except <i>Anthostomella</i> and <i>Lopadostoma</i> . Very poorly represented in the aplanate carbonaceous members of <i>Hypoxylon</i> section <i>Applanata</i> , <i>Nummularia</i> , <i>Bolinia</i> , <i>Camarops</i> , <i>Camillea</i> , <i>Theissenia</i> , and <i>Peridoxylon</i> .

10. *Perithecia*. The various shapes of perithecia have at some time been used to establish different genera, but it is hard to state objectively whether or not this is justifiable. Mere linear dimension is probably quite unreliable, as in the case of *Theissenia* which was erected primarily on large perithecial size.

FIGURE I. The Main Stromal Types in the Xylariaceae. (Not drawn to scale).

Diagrammatic representation:—

ectostroma—unaltered

carbonaceous entostroma—solid black

basal tissue of entostroma—stippled; intensity shows degree of discolouration

outer layer of substrate—horizontal lines

inner layer of substrate—vertical lines

1. *Anthostomella*
  2. *Lopadostoma*
  3. *Rosellinia*, uniperitheciate and biperitheciate stromata
  4. *Hypoxylon*, section *Primocinerea*: multiperitheciate
  5. *Hypoxylon* section *Annulata*
  6. *Hypoxylon*, section *Euhypoxylon*
  7. *Hypoxylon*, section *Applanata* & *Nummularia*
  8. *Camillea*
  9. *Entonaema*
  10. *Daldinia*
  11. *Phylacia*
  12. *Thamnomycetes*
  13. *Stilbohypoxyton*
  14. *Kretzschmaria*
  15. *Poronia*
  16. *Podosordaria*
  17. *Xylaria*
- } *Hypoxylon*, sect. *Entoleuca* (Syd.) Martin

The following types of perithecia occur and the writer would regard them as of specific rather than generic value:

<i>Perithecium</i>	<i>Orientation</i>	<i>Outline</i>	<i>Spacing</i>	<i>Arrangement</i>
Typical	Vertical	Globose to oval, longer than broad	Adjacent but not close crowded	Monostichous
Variants (not necessarily related)	Lateral ( <i>Xylaria</i> , <i>Thamnomycetes</i> )	Conical, hemispheric; or tubular ( <i>Camillea</i> , <i>Camarops</i> )	Well apart ( <i>Rosellinia</i> ) or close crowded ( <i>Nummularia</i> , <i>Camillea</i> )	Polystichous ( <i>Bolinia</i> )

11. *Ostioles*. The ostiole in the Xylariaceae merely refers conventionally to the entrance of the perithecium at the exterior of the stroma, but in practice the term includes the tissue immediately surrounding it. The formation of the ostiole is not a simple event, such as the cracking of the outer crust, but it is a definitely ordered process. In the majority of cases the details are hard to work out because of the large quantities of black material that obscure the sections. The following facts are evident, however:

- (a) the papillate ostiole, characteristic of the majority of the Xylariaceae with the hard rigid stromal layer (3), represents a localized development of the entostroma and becomes indistinguishable from the rest of it;
- (b) the truncate or annulate ostiole referred to by Miller (1961, pp. 9, 86 and elsewhere) is formed by the sloughing off of a circular plaque of the ectostroma around the ostiole, leaving it and part of the entostromal crust exposed. This occurs specifically in certain closely related species of *Hypoxylon* (the Annulate group) and intermittently through the rest of the Xylariaceae;
- (c) the umbilicate ostiole in noncarbonaceous species (*Hypoxylon*, section Euhypoxylon of Miller), represents another type of development in which the papillate portion described above is deliberately released, leaving a pore that is often circumscribed and usually periphysate. Umbilicate ostioles also occur in carbonaceous species of the Applanata section of *Hypoxylon*. In some (*H. tinctor*) they are apparent simply because the ectostroma overlies the carbonaceous layer and when worn away will expose normal papillate ostioles, while in others (*H. punctulatum*) the carbonaceous layer simply appears not to form a protrusion.

The close correlation of the ostiole development with stromal type makes its character, when interpreted correctly, of major value in classification.

12. *Asci*. The structure of the ascus is another feature little investigated. That it is basically unitunicate was determined by Luttrell (1951, p. 58) and

presumably confirms the advanced position of the Xylariaceae. The most interesting part is, however, the amyloid "ascal plug", stainable by iodine, which is mentioned frequently in the specific diagnoses of Saccardo (1882, et seq.), Dennis (1956, 1957) and Carroll (1963). The structure is rectangular, cubic, discoid, or flattened, rarely absent, and differentiates early in the development of the ascus at the apex of the ascospore column. Although the plug is longitudinally cleft in the centre, the ascospores bypass it during dehiscence, so that the function, if any, is vague. Taxonomically, since there is a good correlation between the shapes just listed and other characters especially stromal ones, it should be regarded as a major criterion.

TYPE OF ASCAL PLUG	GENUS
(1) None at all	<i>Hypoxylon</i> section Euhypoxylon
(2) Flattened disc (Fig. II, 9)	<i>Lopadostoma</i> <i>Hypoxylon</i> subsection <i>Papillata</i> sections Annulata and Euhypoxylon <i>Daldinia</i> <i>Phylacia</i> <i>Thamnomycetes</i> <i>Entonaema</i> <i>Hypoxylon</i> section Applanata <i>Camarops</i> <i>Nummularia</i> <i>Bolinia</i> <i>Theissenia</i> <i>Peridoxylon</i> <i>Camillea</i>
(3) Broader than high (Fig. II, 10)	<i>Anthostomella</i> <i>Rosellinia</i> <i>Hypoxylon</i> subsect. <i>Primocinerea</i> <i>Hypoxylon</i> section Applanata <i>Penzigia</i> <i>Stilbohypoxyton</i> <i>Kretzschmaria</i> <i>Xylaria</i> <i>Poronia</i> <i>Podosordaria</i>
(4) Cubic to Rectangular (Fig. II, 11)	<i>Rosellinia aquila</i> and related species <i>Xylaria</i>
(5) Similar to (4) but with rounded lower end and a constriction below the upper end (Fig. II, 12)	

Other features of minor importance are the ascal shape, thickness of wall, duration after maturity, number of spores (8, rarely 4), arrangement of spores, the ratio of fertile to sterile portion (stipe), and the absolute size.

13. *Spore size.* Of all the characters, size has been considered paramount in mycological literature. Miller (1961), in fact, uses it to segregate most of his species. The writer has found that some species groups, (*Kretzschmaria* and the Applanata section of *Hypoxylon*) contain some members with very long spores, but that otherwise spore dimensions are of no generic value. Furthermore the value of spore sizes for specific destination is diminished by:

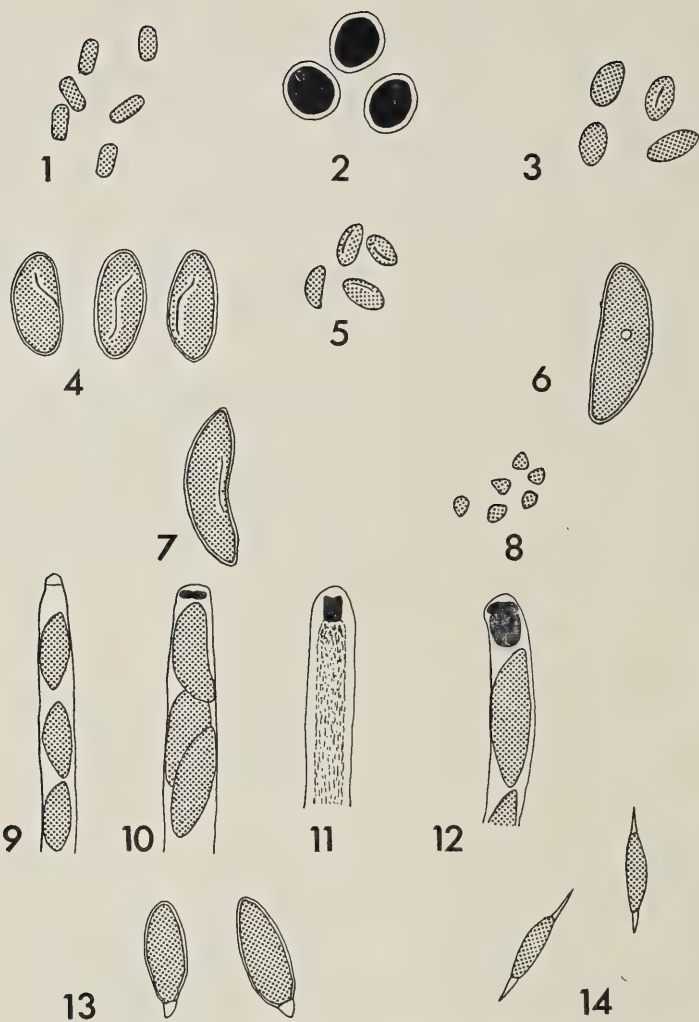


FIG. II. Types of Asci and Spores and their characters.

1. *Phylacia surinamensis*: globose spores with parallel sides. 2. *Numulariola (Nummularia) discreta*: globose spores with thick hyaline sheaths. 3. *Hypoxylon mastoideum (Rosellinia mastoidea)*: oval equilateral spores. 4. *Xylaria longipes*: Oval—elliptic, gibbous spores with spiral germ slit on the less convex sides. 5. *Hypoxylon rubiginosum*: navicular spores with straight germ slits on the convex sides. 6. *Numulariola (Hypoxylon) divergens*: navicular spore with poroid germ slit. 7. *Xylaria polymorpha*: broad crescentic spore with straight germ slit on the concave side. 8. *Numulariola polysperma (Camarops polyspermum)*: spores with one end conical. 9. *Lopadostoma (Anthostoma) turgidum*: ascus with very thin apical plug. 10. *Hypoxylon rubiginosum*: ascus with discoid plug. 11. *Anthostomella nitidissima*: young ascus with rectangular plug. 12. *Hypoxylon pulcherrimum (Rosellinia pulcherrima)*: ascus with rectangular plug and constriction. 13. *Anthostomella sabalensioides*: spores with a hyaline apiculus on the proximal end. 14. *Hypoxylon thelenum (Rosellinia thelena)*: spores with acicular apiculae.



- (a) the great range, especially for length, within a single sample;
- (b) the occurrence, though infrequent, of two separate sizes within the same stroma (*Hypoxylon rubiginosum*);
- (c) the frequent disparity in spore sizes between different collections of otherwise similar stromal material.

In the majority of the Xylariaceae, the average spore lengths are less than  $15\mu$ ; but the entire range extends from 2 up to  $100\mu$ . One might regard small differences between the smaller spores as having greater value than those between larger spores, or one might give equal weight to equal intervals, but either case involves subjective interpretation and it is not easy to find mathematical formulae to cover all possibilities. For the present, the writer has accepted differences of  $2\mu$  in the spore average between samples as indicating separate specific rank, but only when they are allied with differences in the major characters.

14. *Spore shape*. The spores fall into six definite categories, although there are usually intergrades in each sample:

- (a) equilateral with sides parallel (cylindric); *Camillea*, *Phylacia*, *Thamnomycetes*; (Fig. II:1)
- (b) equilateral, side convex (globose to elliptic); All genera; (Fig. II:2, 3)
- (c) inequilateral, sides convex (gibbous); All genera; (Fig. II:4)
- (d) one side convex, the other flat (navicular); All genera except in *Camillea*, *Phylacia*, *Thamnomycetes*; (Fig. II:5, 6)
- (e) one side convex, the other concave (broad crescentic); Section *Applanata* of *Hypoxylon*, and *Xylaria*, and *Kretzschmaria*; (Fig. II:7)
- (f) semi-triangular; *Camarops*; (Fig. II:8)

Spore shape can only be used on a specific level but its main interest lies in the fact that there is a clear if incomplete association of elongate navicular or crescentic spores with those species of *Penzigia*, *Kretzschmaria* and *Xylaria* in which the stroma contains white basal tissue and a similar prevalence of short oval to elliptic spores in other species. Certain species groups (Miller's section *Euhypoxylon* of *Hypoxylon*, and the genus *Daldinia*) contain no elongate spores at all. When more is known about the tropical species, further analysis of these characters will prove interesting.

15. *The germ slit*. There are three types that can be distinguished: elongate straight, (Fig. II:3, 5) elongate spiral, (Fig. II:4) and poroid, (Fig. II:6). The first can occur on the concave or convex sides of inequilateral spores, the second on the concave side only, and the third apparently anywhere on the spore. The interest of this lies in the restriction of the spiral type to some species within *Rosellinia*, *Penzigia*, *Kretzschmaria* and *Xylaria*; which is, incidentally, the same generic distribution as for the subiculum. In addition, all the latter three genera have the germ slit on the concave side of inequilateral spores and the same is

true for the majority of inequilateral spores in *Rosellinia*. The value of the character is limited only by the fact that it is impossible to know at present which side of the equilateral spores corresponds to the flat-sided or concave one of the inequilateral spores so that no general homology covering all spores may be made.

16. *Spore sheath*. This character lends weight to the validity of some of the established taxa but its inconstancy prevents it from being used to differentiate absolutely between them.

- (1) No sheath recognisable

*Hypoxyton*, sections:

*Euhypoxyton*

*Papillata*

*Applanata*

*Nummularia* and allied genera

- (2) Sheath distinct:

*Anthostomella*

*Lopadostoma*

*Rosellinia* spp. with dark subiculum

*Hypoxyton* subsection *Primocinerea*, part

*Kretzschmaria*

*Xylaria* and allied genera

- (3) Sheath very prominent: (Fig. II:2)

*Nummularia discreta*

*Podosordaria* spp.

17. *Spore apiculus*. (Fig. II:13, 14) Though apparently continuous with the spore sheath and of the same substance, the distribution of apiculae throughout the family follows a different pattern from that of the spore sheath. Apiculae are characteristic of *Anthostomella*, part of the section *Applanata* of *Hypoxyton*, and are occasionally found in *Rosellinia* and *Xylaria*. They are usually short and are borne on one or both ends of the spore. Rarely are they acicular as in *Rosellinia thelena*. The apiculae provide good specific characters, but unfortunately they frequently disappear after maturity.

#### B. Cultural characters.

The following information is based on the culture of some 600 strains of the Xylariaceae. The most significant results were obtained when malt agar was used as the culture medium.

18. *General macroscopic growth characters*. No culture type was found exclusively for any species group based on stromal characters. Submersed, canescent or velvety types, usually not producing stain, occurred throughout. The following table shows the most important correlations, descriptions being

based on 14-day-old plate cultures grown on malt agar. For terms applicable to the mycelium the writer has used the definitions provided by Long and Harsch (1918).

TYPE	FOUND IN
(1) Colonies submersed to canescent, smooth dull white, hyaline or subhyaline; conidial formation usually profuse and rapid, or else absent entirely; stain absent or slight. Conidia fawn to grey, growth slow to moderate (0—4.0 mm per day at 25°C).	<i>Anthostomella</i> (part) <i>Rosellinia</i> (part) <i>Hypoxylon</i> subsect. <i>Primocinerea</i> (part) (Plate III:2) <i>Hypoxylon</i> sect. <i>Euhypoxylon</i> (part)
Conidia red brown or orange brown, growth variable.	
(2) Colonies silky with smooth strands overlaying a felty interior; white, but often with "carbonization" of the medium present in small oval patches at the base of the colony with age; stain absent; growth rapid (>4.0 mm per day at 25°C).	<i>Rosellinia necatrix</i> and close relatives
(3) Colonies velvet felty to fleecy uniform or zonate, white, subhyaline to opaque, usually smooth; "Carbonization" of the medium often present; stain absent; growth moderate to slow (0—4.0 mm per day at 25°C).	<i>Anthostomella</i> (part) <i>Hypoxylon</i> subsect. <i>Primocinerea</i> (part) (Plate II:1, 3, 6; Plate III:5)
(4) Colonies velvet to fleecy or floccose, rough or smooth, uniform or zonate, sometimes plumose, normally with pronounced tendency to coremial formation; carbonization of the medium usually very marked; stain none; growth moderate (2.0 mm/day—4.0 mm/day).	<i>Kretzschmaria</i> <i>Penzigia</i> <i>Xylaria</i> <i>Poronia</i> <i>Podosordaria</i> (Plate II:7; Plate III:6; Plate V:1—3)
(5) Colonies velvet felty, dull white or variously coloured, subhyaline or opaque, surface smooth or coarse; carbonization rare; stain usually pronounced, some shade of amber, ochre yellow, red-brown, red or violet; growth moderate (>2.0 mm/day) to fast (>4.0 mm/day).	<i>Hypoxylon</i> , subsect. <i>Papillata</i> section <i>Annulata</i> <i>Phylacia</i> <i>Daldinia</i> (Plate II:2)
(6) Colonies coarse felty or cottony, rarely somewhat velvety, dull white or variously coloured, subhyaline to opaque, carbonization absent; stain flecked or uniform, ochre yellow to red-brown or olive green, usually pronounced. Growth rate rarely below 4.0 mm/day. Secondary mycelium tentacular; surface infrequently showing ropy or straggling hyphae and vertical tufts of mycelium. Secondary mycelium otherwise; surface usually with ropy or straggling hyphae and vertical tufts of mycelium.	<i>Hypoxylon</i> sect. <i>Euhypoxylon</i> (part) (Plate III:4) <i>Daldinia</i> <i>Hypoxylon</i> sect. <i>Applanata</i> <i>Nummularia</i> (Plate II:4 and 5; Plate III:3)

No information is available for *Lopadostoma*, *Bolinia*, *Camarops*, *Camillea*, *Peridoxylon*, *Theissenia*, *Entonaema*, *Thamnomycetes* or *Stilbohypoxydon*. How-



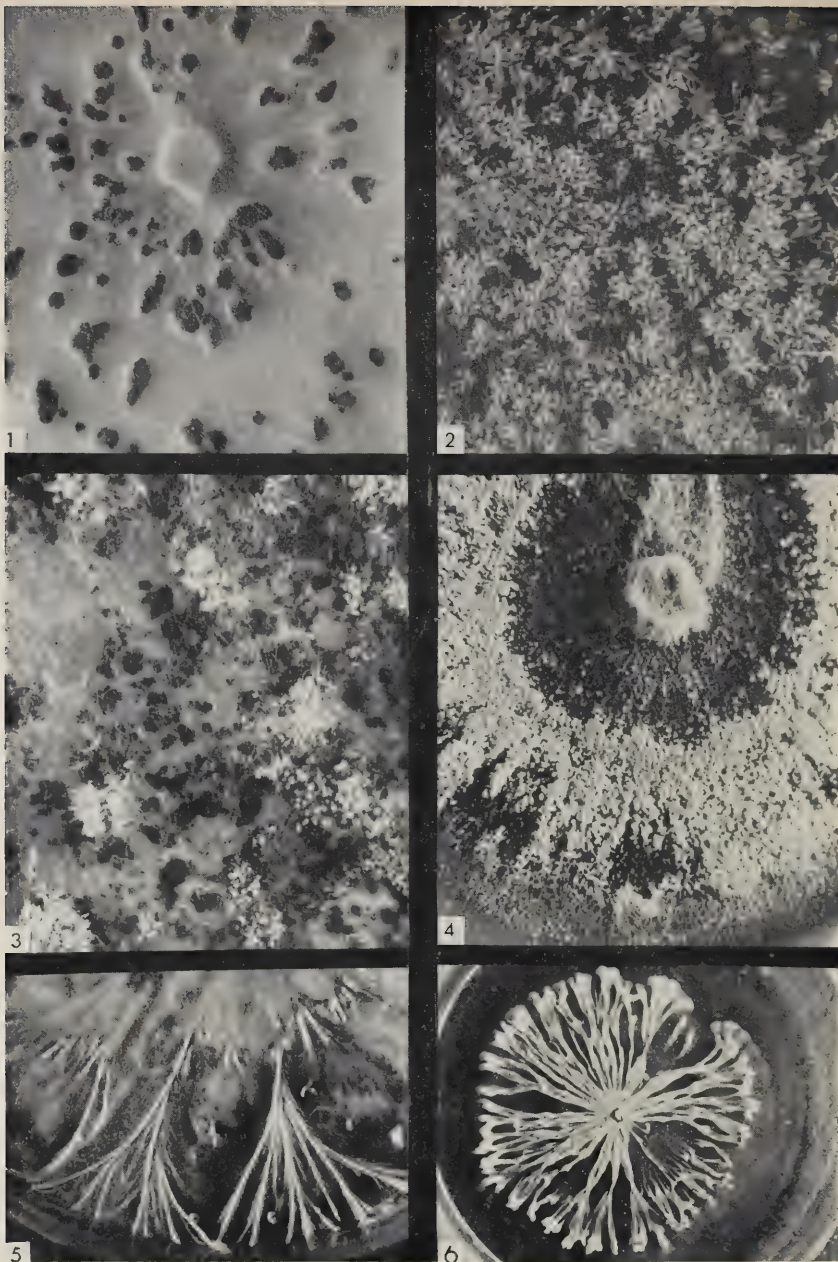


PLATE III.

Types of Colony in the Xylariaceae. II.

1. *Hypoxylon thelenum* (*Rosellinia thelena*): silky mycelium overlaying small carbonaceous areas in fleck formation through the substrate.
2. *Hypoxylon serpens*: canescent mycelium with rapid conidial formation.
3. *Daldinia concentrica*: coarse felty mycelium with dark mycelial aggregates of tentacular mycelium close to substrate level.
4. *Hypoxylon rubiginosum*: felty mycelium with light coloured mycelial aggregates.
5. *Hypoxylon mastoideum* (*Rosellinia mastoidea*): showing plumose hyphae at margin of colony.
6. *Xylaria cornu-damae*: velvet colony with plumose development.

ever this table quite clearly shows broad differences in behaviour between species groups defined on stromal characters. It reinforces the traditional concept, derived from study of perfect stages only, that there are gross affinities between the superficial colourless genera comprising *Xylaria* and its allies on the one hand, and between the genera with an outer pigmented layer on the other. There is, however, a small overlap between the two.

19. *Mycelium*. The primary mycelium shows little in the way of exceptional characteristics. However there does not appear to be correlation between diameter, degree and spread of the marginal hyphae, and the growth rate. The majority of species have growth rates slower than 4 mm/day and hyphae which are close packed and less than 3 mm diameter, while a small number of species in *Daldinia* and in the section *Applanata* of *Hypoxylon* have faster growth rates and widely spread "pioneer" hyphae of at least 3 mm diameter. The dark-subiculate species of *Rosellinia* on the other hand are fast growers, but may have narrow marginal hyphae.

The secondary mycelium which develops as the colony matures, is more interesting in its variation. Five basic types exist altogether in the Xylariaceae, which show direct resemblance to the subicular types of mycelium occurring in nature that have already been described (p. 10). The ropy type (2) is the most common. In contrast to the first four types of mycelium however, the fifth type is infrequent in the field, while in culture it is characteristic of *Daldinia* and of 3 species in *Hypoxylon* sect. *Euhypoxylon*: *H. subchlorinum*, *H. howeianum* and *H. sclerophaeum*. This incidentally confirms the affinity already noted between the two genera.

In some cultures certain characteristic structures develop with age that may be termed *mycelial aggregates*. These are cushion-shaped or spherical pads of mycelia chiefly composed of secondary mycelium when mature though largely primary at first. They occur in all cultures of *Daldinia*, sporadically in *Hypoxylon* sections *Euhypoxylon*, *Annulata* and *Papillata*, and occasionally in the section *Applanata* (*Hypoxylon mediterraneum*).

Further inspection of the cultures also showed that:

- (a) secondary mycelium was absent from species of *Anthostomella* and absent or weakly developed (type 1) in *Rosellinia* and *Primocinerea*;
- (b) the type of mycelium in the stromal subiculum may not always agree with that formed in culture by the same strain. Hence it is difficult to decide how fundamental the differences in mycelial development are.

20. *The Imperfect stage*. The imperfect stages of the Xylariaceae have only been sporadically described in the literature and never made use of in classification. It is difficult to account for this lack of observation because conidia are often easy to find developing freely or in coremia on the surfaces of most



developing stromata, or in close association with them. The earliest mention of a conidial stage is that of Persoon (1808) in his description of *Isaria umbrina*, associated with *Hypoxylon fragiforme*. With few exceptions, the later writers only concerned themselves with the dark-subiculate species in *Rosellinia* which contain many pathogens of economic importance such as *R. necatrix* (Berlese, 1892; Brooks, 1953; Hansen, Thomas, and Earle 1937; Hartig 1883, 1894; Prilleux, 1904), *R. quercina* (Hartig, 1880) and *R. radiciperda* (Masse, 1896), with *Nummularia discreta* (Gloyer, 1921; Hasselbring, 1902), with *Hypoxylon deustum* (sub *Ustulina*: Brooks, 1915; Petch, 1912, 1921, 1923; Wilkins, 1936, 1938, 1939) and with various species of *Xylaria* (Brown, 1913; Fromme, 1928; Guéguén, 1906, 1907, 1909; Petch, 1907, 1913, 1927). The chief attempts to combine conidiophore and conidial morphology with that of the stroma for a large number of species are those of Jaczewski (1896, pp. 110–136) and Traverso (1906, pp. 31–172).

In the present investigation the number and variety of conidiophore types have been found sufficiently large to be of significant value in the delimitation of species and even genera but their contribution to the overall picture is diminished by two disadvantages:

- (a) not all stromata, even when collected at or after maturity, will germinate on malt agar or on more complex synthetic agars and a sizeable minority of those that do, still fail to fruit;
- (b) two or more types of conidiophore and/or cultural type may belong to stromal forms which resemble each other very closely.

The variation in linear measurements of various characters also may vary so greatly that it is difficult to determine which are really significant. If all the available characters from both perfect and imperfect stages were given equal weight it would often be very hard to draw specific distinctions among samples between which there is apparently equal taxonomic distance.

The following table shows the distribution of the conidiophores for 95 species of the Xylariaceae. *Hypoxylon* is somewhat over-represented due to the greater ease of obtaining conidiophores in culture, while *Nummularia*, *Bolinia*, *Lopadostoma*, *Phylacia* and *Thamnomycetes* are poorly represented for the opposite reason. No fresh material for culturing was available for *Entonaema*, *Camarops*, *Theissenia*, or *Stilbohypoxydon*. The fractions of the species total and the same expressed as a percentage are figured in each column.

The distribution of conidiophore types in such a definite arrangement can hardly be ascribed to chance, and there does appear to be a reasonable correlation with stromal characters. Perhaps the most interesting feature is the distribution of coremial types. The "ropy" type occurs, though in small numbers, throughout the dark-subiculate members of *Rosellinia* and the sections Papillata

TABLE I  
Correlation of Conidiophore Types with the Genera of the Xylariaceae (as traditionally defined)

Genus or Subsection	Conidia borne on			Nodulisporium		Sporothrix						Acrostaphylus		Basidio- botrys
	Hyphae	Ropy Coremia	Stromatic Coremia	Type I	Type II	Type I	Type II	Type III	Type IV	Type V	Type I	Type II		
<i>Anthostomella</i>	No. of Species 4/4 100	0	0	1/4 25	3/4 75	0	0	0	0	0	0	0	0	0
<i>Lopadostoma</i>	No. of Species 7/12	5/12	0	0	12/12	0	0	0	0	0	0	0	0	0
<i>Rosellinia</i>	No. of Species 38 42	0	0	4/13 31	9/13 69	0	0	0	0	0	0	0	0	0
* <i>Hypoxylon</i> subject, Primocinerea	No. of Species 13/13 100	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Hypoxylon</i> subject, Papillata	No. of Species 4/4 100	2/4	0	0	0	0	4/4	0	0	0	0	0	0	0
<i>Hypoxylon</i> section Annulata	No. of Species 4/4 100	0	0	0	0	0	100	0	0	0	0	4/4	0	0
<i>Hypoxylon</i> section Euhypoxylon	No. of Species 25/25 100	3/25	0	0	0	8/25	11/25	3/25	3/25	7/25	3/25	2/25	0	0
<i>Daldinia</i>	No. of Species 5/5 100	12	0	0	0	3/5	3/5	12	1/5	28	12	8	0	0
	No. of Species % 100	0	0	0	20	60	60	0	20	0	0	60	0	0
<i>Entonaema</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Phylacia</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Thamnomycetes</i>	No. of Species 11/11 100	0	0	0	0	1/11	2/11	0	0	0	3/11	7/11	3/11	—
section Applanata	No. of Species 2/2 100	0	0	0	0	0	9/18	0	0	0	27	64	27	—
<i>Nummularia</i>	No. of Species 2/2 100	0	0	0	0	0	0	0	0	0	2/2	0	0	—
<i>Canarops</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Theissenia</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Camillea</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Bolonia</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Kretzschmaria</i>	No. of Species % 0	0	1/1 100	0	0	0	0	0	0	0	1/1 100	0	0	—
<i>Stilboidypoxylon</i>	No. of Species 1/3† 33	0	2/3	0	1/3† 33	0	0	0	0	0	0	2/3	0	—
<i>Penzigia</i>	No. of Species % 33	0	66	0	33	0	0	0	0	0	0	66	0	—
<i>Xylaria</i>	No. of Species % 33	0	9/9	0	1/9	1/9	2/9	0	0	1/9	0	5/9	0	—
<i>Poronia</i>	No. of Species % 0	0	100	0	11	1/1	22	0	0	11	0	56	0	—
	No. of Species % 0	0	100	0	0	1/1	100	0	0	0	0	0	0	—
<i>Podosordaria</i>	No. of Species % 33	0	2/3	1/3 33	0	1/3 33	0	0	0	0	0	1/3 33	0	—

\* Includes *H. densium*, to be transferred to *Kretzschmaria*

† *Penzigia discolor*, to be transferred to *Hypoxylon* (Entoleuca: Primocinerea)

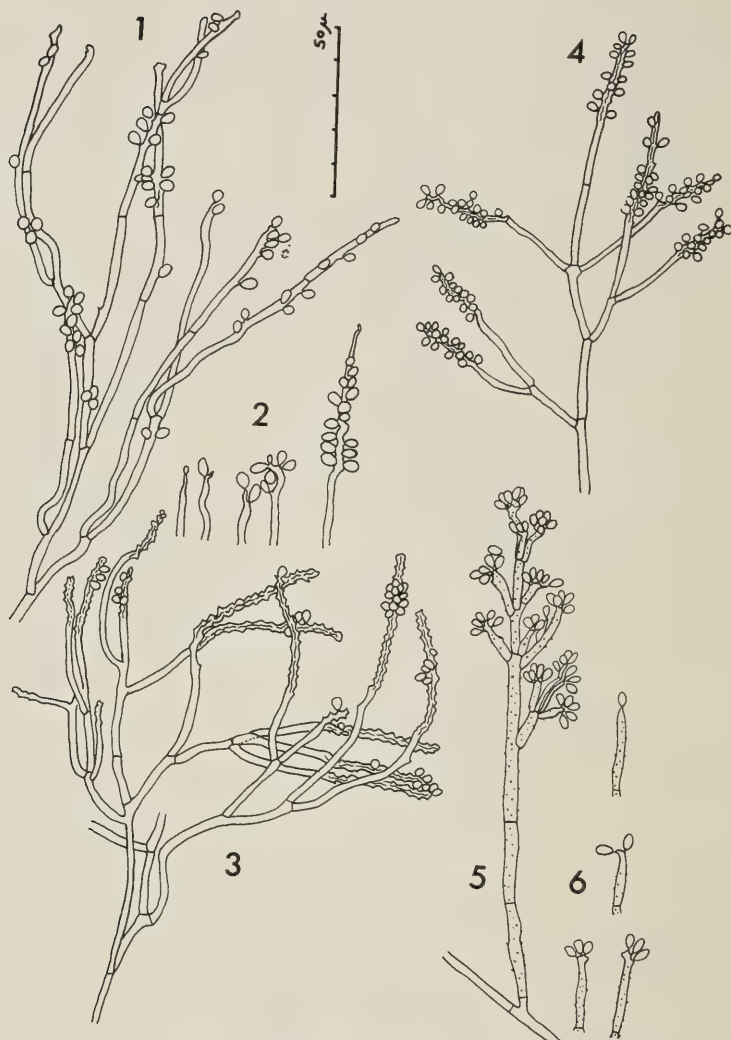


FIG. III. Conidiophores in the Xylariaceae. I.

1. *Hypoxylon albocinctum*: *Nodulisporium* type I. 2. *Hypoxylon albocinctum*: showing development of the conidia. 3. *Anthostomella melanotes*: *Nodulisporium* type II. 4. *Hypoxylon (Rosellinia) mastoideum*: *Nodulisporium* type II with predominantly ternate branching. 5. *Hypoxylon truncatum*: *Acrostaphylus* type 1. 6. *Hypoxylon truncatum*: showing development of the conidia. Compare with 2.

and Euhypoxylon of *Hypoxylon* (Plate IV:1-5). These are minute, not exceeding 4 mm in length, and are composed of dark uniform hyphae more or less parallel or coiled, bearing conidiophores at the surface. No differentiation takes place between the inner and outermost hyphae and the coremia remain short aristate, though sometimes connected together at the base, as in *Hypoxylon fragiforme*. The "fleshy" type is characteristic of *Kretzschmaria*, *Xylaria*, *Poronia* and *Podosordaria*, and is usually larger in size, extending up to 6 cm (Plate IV:6; Plate V:1-6). There is usually a distinct resemblance towards the structure of the stroma in species of *Xylaria* in that an outer layer of dark intertwined hyphae, sometimes impregnated with rigid "carbonaceous" material, is differentiated from an inner white fleshy core. The base of the coremium often bears long brown setose hyphae, the middle section is usually glabrous, grey, black, or white, while the apex may remain white or flesh-colour or develop a "collar" tinted white, yellow or orange. The smaller coremia, below 15 mm high, often lack the central grey-black section and are more or less uniformly pale. The fleshy coremia are by no means necessarily fertile; repeated culturing of many *Xylarias* seems to indicate that sterility may be normal, or the period of formation of conidiophores to be long delayed. Conidia, when developed, occupy the apex or sides of the coremium or both, and tend to obscure the features described above. In the large members of *Xylaria*, particularly in coremia grown in the field, the conidiophores are parallel, forming a palisade, but outside these the conidiophores are randomly orientated and easily separable for examination.

The coremium of the Xylariaceous groups of genera probably represents the initial stages of the stroma in most cases, perithecia later developing below the conidial region. Yet this too is not obligatory, since many withered coremia can often be found in the field associated with mature stomata. As in the rest of Xylariaceae, no coremial culture has yet given rise to stomata under laboratory conditions, whether on wood or agar. The formation of stomata obviously requires some subtle factor or principle not yet understood.

### *Classification of the Imperfect Stages*

This is a difficult task because the imperfect form genera themselves overlap in concept, and are often not capable of precise definition. The fungi show wide variations, often within the same sample, in total length, degree of branching and arrangement of the branches, and also a certain variation in degree of colouration. All these characters are classically adopted in the division of the Fungi Imperfecti.

The coremia, which are classified mainly on external morphology, can be assigned to the genera *Graphium* (ropy type) and *Isaria* (fleshy type). Several



FIG. IV. Conidiophores in the Xylariaceae II.

1. *Hypoxyylon rubiginosum* and *H. oodes*: *Sporotrichum* type I. 2. *Hypoxyylon fuscum*: *Sporotrichum* type I, also with conidia in fascicles off the sides of the hyphae. 3. *Hypoxyylon investiens*: *Sporotrichum* type II. 4. *Hypoxyylon aureostroma* sp. nov. (Section Euhypoxyylon): *Sporotrichum* type III. 5. *Hypoxyylon hypomiltum*: *Sporotrichum* type IV. 6. *Hypoxyylon murcidum*: *Sporotrichum* type V. 7. *Xylaria digitata*: *Sporotrichum* type V. 8. *Hypoxyylon rubrostromaticum*: *Acrostaphylus* type I. 9. *Xylaria ianthino-velutina*: *Acrostaphylus* type II.



authors, notably Brooks (1953), Lloyd (1916, 1917a, 1917b, 1918, 1923a, 1923b) and Petch (1910, 1923) have recognised this connection. Traverso (1906, p. 172) has also reported and figured an acervular type of fruiting body for *Lopadostoma* (sub *Anthostoma melanotes*), somewhat similar to *Cytospora*, but this remains to be confirmed.

The conidiophores of the Xylariaceae can be divided into three fairly distinct types based on method of origin of the conidia and the degree of distinction of the conidiophore from the vegetative mycelium.

1. *Nodulisporium* Preuss. (Fig. II:1-4). The conidiophores are usually very long, lax, much branched, often exceeding  $500\mu$ . The structures may not be easily differentiated from the vegetative mycelium because the hyphae are alike in diameter. The conidia arise laterally and apically off the sides of the fertile branches, the tip of which bends away from the point of origin of each spore before giving rise to the next one. This bending takes place in one or more planes but the net effect is a characteristic geniculate pattern with the conidia remaining attached in the notches along the fertile branch. The fertile branch may only start fruiting late in its development, in which case the conidial area will be short, or it may fruit throughout much or nearly all of it. The writer considers the latter condition to be the most primitive since it is accompanied by the least degree of differentiation, and is therefore designated type I, and the other as type II. We can also recognise two forms within the second type, those with dichotomous branching (IIa) and those with ternate branching (IIb), but the distinction is not sufficiently consistent between species to be useful.

The conidia are one-celled, subglobose to long clavate, with the distal end narrow or broad-rounded and the proximal distinctly truncate due to the wide area of attachment. The colour varies from white to deep grey or fawn brown, not being as diverse as the types to follow.

The *Nodulisporium* stage is characteristic of *Anthostomella*, *Rosellinia*, and the Primocinerea subsection of *Hypoxylon*, and it occurs sporadically in *Daldinia*, *Penzigia*, *Xylaria* and *Podosordaria*. There is no major difference in form between any of these apart from the distribution of the conidia, and both types defined above are universal. The correlation with the stroma type is therefore a rather wide one.

2. *Sporothrix* Hektoen & Perkins (1900). (See also Carmichael, 1962). The conidiophores vary from very long to extremely short and are unbranched or indefinitely ramose and penicillate, but they are always the same diameter as the vegetative mycelium and smooth-walled. (Fig. IV: 1-6, 8). The conidia are shortly pleuracrogenous or are borne almost at the same level at the apex, with the oldest near the base and the youngest in the centre. If the apex continues growth after fruiting, the conidia are left behind as a fascicle, or very rarely



FIG. V. Conidiophores in the Xylariaceae III.

1. *Hypoxylon sclerophaeum*: *Acrostaphylus* type II. 2. *Hypoxylon haematostroma*: *Acrostaphylus* type II. 3. *Numulariola nummularia* (*Hypoxylon nummularium*): *Acrostaphylus* type II. 4. *Numulariola mediterranea* (*Hypoxylon mediterraneum*): showing variation in *Acrostaphylus* types. 5. *Numulariola* (*Hypoxylon*) *tinctor*: simple *Acrostaphylus* type I. 6. *Numulariola* (*Hypoxylon*) *tinctor*: showing development of the compound *Basidiobotrys* conidiophore. 7. *Numulariola* (*Hypoxylon*) *tinctor*: mature, typical, compound *Basidiobotrys* type. 8. *Numulariola punctulata* (*Hypoxylon punctulatum*): *Basidiobotrys* type. 9. *Numulariola mediterranea* (*Hypoxylon mediterraneum*): *Basidiobotrys* type. 10. *Numulariola mediterranea* (*Hypoxylon mediterraneum*): *Acrostaphylus* type associated with above.

singly. The fertile branches are never geniculate, and the conidia are sessile or attached by a broad or narrow sterigma. Due to this variation, the proximal end may be narrow truncate, rounded or acuminate, and the shape correspondingly varies from clavate to oval or elliptic to napiform and pyriform. The colour varies between white, grey, yellow, pink, fawn-brown, red-brown and dull-brown.

The *Sporothrix* type can be subdivided into a number of intergrading variants on the degree and type of branching:

- I. unbranched and usually short; *Hypoxylon* sect. *Euhypoxylon*;
- II. branched to the first or second degree or indefinitely; branching mainly dichotomous but sometimes with sporadic verticils.

<i>Hypoxylon</i>	{	subsect. <i>Papillata</i> sect. <i>Euhypoxylon</i> sect. <i>Applanata</i> (occasional)
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*Daldinia*  
*Xylaria*  
*Poronia*

- III. apparent axes sparingly branched, with long fertile axes along which the conidia are clustered in repeated fascicles or off short terminal hyphae; branching is sympodial, and the verticils or terminal hyphae represent the ends of successive main axes: *Hypoxylon* sect. *Euhypoxylon* only;
- IV. with the majority of branching ternate and the ends of the branches swollen into a distinct globose flaring head; the branches are aligned with the main axis to resemble a trident: *Hypoxylon* sect. *Euhypoxylon* only;
- V. with the majority of branches verticillate, 3–6 branches per node, resembling *Calcarisporium*: *Hypoxylon* sect. *Euhypoxylon*, and *Xylaria*.

3. *Acrostaphylus* Arnaud ex Subramanian (1956). (Fig. III:5 and 6; Fig. IV:8 and 9; Fig. V). The conidiophores are of the same general plan as in *Sporothrix* but differ in that the axis is well defined, with the branches usually over the upper half only, and the fertile branches and axes are stout in relation to the vegetative mycelium. Warty walls and an amber, yellow, brown or purplish tint are further characteristic but inconstant features. Subramanian (1956, p. 482) clearly regards the genus as belonging to the Dematiaceae, but this is doubtful as the conidia are always light coloured and the conidiophores rarely opaque. The conidia are similar in form and method of origin to those of *Sporothrix*.

The series can be divided into four groups though again there are many intergrades:

- I. conidiophores simple, dichotomous, ternate or verticillate; fertile

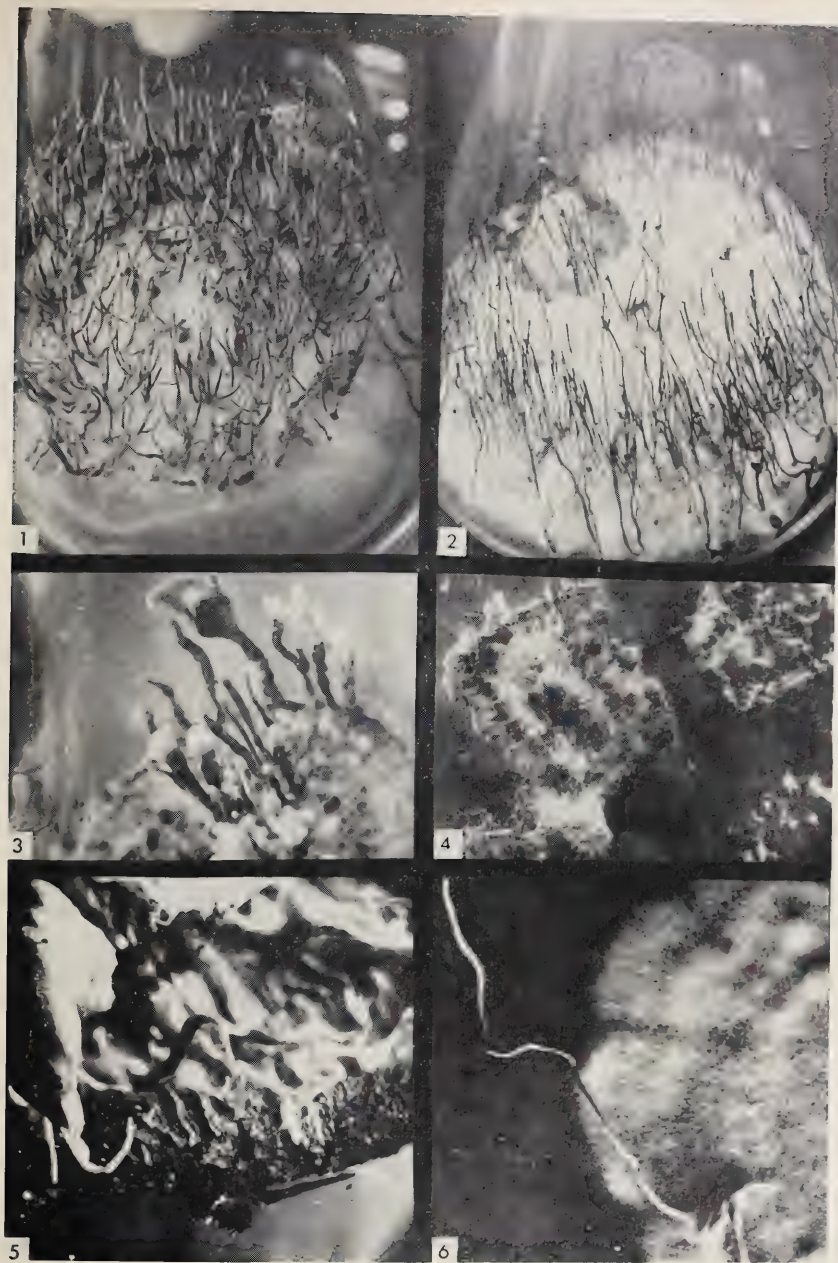


#### PLATE IV.

##### Types of Coremium in the Xylariaceae. I.

1. *Hypoxylon* (*Rosellinia*) *necatrix*: *Graphium* type, also known as *Dematophora*, on cotton plug.  $\times 8$ .
2. *Hypoxylon necatrix*: microscopic view of above.  $\times 60$ .
3. *Hypoxylon fragiforme*: coremia forming a circlet around the base of the developing stromata. This type has been called *Isaria umbrina* Pers. but it is closer to *Graphium*.  $\times 8$ .
4. *Hypoxylon oodes*: microscopic view of coremia structure similar to (3).  $\times 60$ .
5. *Hypoxylon cohaerens*: dendroid coremia, not arising in any particular order.  $\times 8$ .
6. *Xylaria digitata*: apex of fleshy coremium, *Isaria*-type.  $\times 60$ .





# PLATE V.

Types of Coremium in the Xylariaceae. II.

1. *Xylaria subtrachelina*: general habit of coremia. } in flask culture, 14 days old on
2. *Podosordaria (Xylaria) sicula*: general habit of coremia. } 2% malt agar at 25°C.  $\times 0.8$ .
3. *Xylaria polymorpha*: general habit of spatulate and clavate coremia.  $\times 0.8$ .
4. *Xylaria fioriana*: acervular fruiting areas on agar surface.  $\times 3$ .
5. *Kretzschmaria heliscus*: variation from spatulate to aristate coremia.  $\times 8$ .
6. *Podosordaria pyramidata*: long dendroid covemium  $\times 3$ .



branches stout but not clavate, walls often smooth. This type is intermediate with *Sporothrix*, and is found in *Hypoxylon* section *Annulata* and in *Nummularia*.

- II. As above, but fertile branches clavate or swollen, usually with bulbous ends: (a) warted: *Hypoxylon* section *Applanata*

*Daldinia* (mainly) section *Euhypoxylon*

(b) not warted: *Xylaria*

*Penzigia*

- III. conidiophores themselves with characteristic long swollen clavate terminal regions off which a number, usually 50–100, of short clavate fertile branches arise. This is known as *Basidiobotrys* v. Hoehnel (1909), (Fig. V:6–10) and is structurally the most complex in the *Xylariaceae*. This stage has been described for *Hypoxylon punctulatum* by Barnett (1957), and is found in other species of the *Applanata* section of *Hypoxylon*.

In general we can conclude that there is a most interesting parallelism between conidiophore type and degree of stromal variation.

#### CONCLUSION

The problem of combining these characters discussed above so as to give the best possible classification is a formidable one. The objective approach to this will be the subject of a later paper. For the moment the author is content to decide the limits of the genera in the light of his own concepts. The many similarities between stromata that were formerly classed apart, and the correlation between perfect and cultural characters would seem to indicate that the twenty-one presently recognised genera contain many that are redundant, and that only twelve would appear to be valid.

There are also two persistent mistakes in nomenclature that must be corrected:

- (a) The genus *Anthostoma* Nitschke was made redundant by Traverso in 1906 and two genera *Anthostomella* and *Lopadostoma* substituted. Most of the species still wrongly ascribed to *Anthostoma* are clearly referable to *Anthostomella* as a succeeding paper will show.
- (b) The genus *Nummularia* Tulasne (1863) is invalid since it was preceded by *Nummularia* Riv. ex Rupp in 1745 and by its synonym *Numularia* Gilib. in 1781. Both these angiosperm genera are listed in *Index Kuensis*, edited by Hooker and Jackson (1895). House (1925) has correctly substituted the name *Numulariola*.

The main revisions in classification are summed up in the following key to the *Xylariaceae*:

1. Stromata small, one to few peritheciate, discoid or pulvinate or valsoid, erumpent or remaining immersed in the substrate; outer layer of substrate fused with the ectostroma and persistent around the rest of the stroma, sometimes blackened by it; basal tissue absent or slight; ostioles usually tubular, less commonly papillate or umbilicate . . . . .
- 1' Stromata small to large, superficial or erumpent but not valsoid nor with substrate attached except around the margin, nor with tubular ostioles; basal tissue often slight but definitely present . . . . .
2. Stromata valsoid, ascal plugs discoid or flattened . . . . .
- 2' Stromata variable, discoid to pulvinate or aplanate effuse, ascal plug cubic or rectangular (Conidial stage: *Nodulisporium*) . . . . .
- 3 (1) Stromata erumpent, perithecia immersed, basal tissue dark, carbonaceous layer well developed; stromata variable in form from aplanate to cylindric with no sharp demarcation; carbonous layer black or metallic with ectostroma sparsely retained or absent at maturity; perithecia usually close crowded, ovate or elongate; ascal plugs typically discoid or flattened. (Conidial stage: *Acrostaphylus* or *Basidiobotrys*) . . . . .
- 3' Stromata superficial, or if erumpent then with well developed pale basal tissue or with perithecia clearly evident in outline . . . . .
4. Stromata not extending far above substrate level, and if cylindrical not deeply cupulate; variable in shape or discoid or short cylindrical.  
*Numulariola* sect. *Innata* Martin  
syn. *Bolinia* Nits.  
*Camarops* Karst.  
*Hypoxylo* Bull sect. *Applanata* Mill.  
*Nummularia* Tul.  
*Peridoxylon* Shear.  
*Theissenia* Maublanc.
- 4' Stromata conspicuously raised above substrate level, usually strictly cylindric and usually with cupulate apex.  
*Numulariola* sect. *Camillea* (Fr.) Martin  
syn. *Camillea* Fries.
5. Fertile part of the stroma large, robust, aplanopulvinate to pulvinate or globose, multiperitheciate; perithecia immersed; interior either gelatinous and partly hollow, or corky and zonate with alternating light and dark zones, never concolorous . . . . .
- 5' Fertile part of the stroma various in shape, but with a concolorous interior that is never gelatinous . . . . .
6. Interior gelatinous, pale, with frequent cavities; ectostroma visibly coloured . . . . .
- 6' Interior corky and zonate; if rarely partly gelatinous and hollow, then dark in colour; ectostroma pigmented though often dull at sight. (Conidial stage: *Sporothrix* or *Acrostaphylus*) . . . . .
2. Lopadostoma (Nitschke) Trav.
3. *Anthostomella* Sacc.
- 4: *Numulariola* House emend. Martin.
- 5.
7. *Entonaema* Möller
- Daldinia* C. & Dn.

- 7 (5) Stromata variable in shape but without well-defined ostioles, or ostioles sometimes tubular; entostroma with massive brittle carbonaceous outer layer; ectostroma heavily pigmented though dull at sight . . . . . 8.
- 7' Not with this combination of characters . . . . . 9.
8. Stromata simple or branched but not dendroid, sessile or stipitate; fertile clava globose or turbinate; ostioles obsolescent at maturity . . . . . *Phylacia* Lev.
- 8' Stromata dendroid, usually multibranched, with perithecia borne latterly or in small terminal clavata; ostioles obsolescent or tubular . . . . . *Thamnomycetes* Ehrenberg
- 9 (6) Stroma with no evident carbonaceous layer and pale inside; substrate usually non-lignaceous . . . . . 10.
- 9' Stroma sometimes with no carbonaceous layer but then dark inside; carbonaceous layer accompanied by basal tissue of varying consistency and coloration from white to dark; substrate rarely non-lignaceous . . . . . 11.
10. Ectostroma present, forming a white or brown covering; stromata often branched, with aplanate, discoid or urceolate clavulae. (Conidial stage: *Sporothrix* on *Isaria*-type coremium) . . . . . *Poronia* Gleditsch
- 10' Ectostroma absent, stromata simple, fertile clavata pulvinate or aplanopulvinate. (Conidial stage: *Sporothrix* on *Isaria*-type coremium) . . . . . *Podosordaria* E. & H.
- 11 (9) Perithecia predominantly vertical, if occasionally diagonal or lateral then basal tissue is corky and dark coloured; clavata sometimes club-shaped, more usually pulvinate, hemispheric or ovoid; stipitate or sessile; sterile apices excentric when present . . . . . 13.
- 11' Perithecia predominantly lateral, if diagonally or vertically oriented then basal tissue is fleshy and white; fertile clavata or clavulae club-shaped or cylindric, stipitate or sessile; sterile apices centric when present. (Conidial stage: *Nodulisporium*, *Sporothrix* or *Acrostaphylus* on *Isaria*-type coremium) . . . . . 12: *Xylaria* (including part of *Penzigia*) Hill ex Fr.
12. Stromata usually large, clavate, with bulbous apices and decussate or poorly differentiated stipes; stromal surface smooth; ectostroma continuous, typically bright-coloured; perithecia rarely evident in outline; subiculum infrequent. *Xylaria* section *Xyloglossa* Fries.
- 12' Stromata variable in size and shape but rarely bulbous, sometimes with sterile apices and usually stipitate; surface verrucose, rarely smooth; ectostroma usually fragmented, brown or black; perithecia usually evident; subiculum characteristic. *Xylaria* section *Xylorugosa* Martin  
syn. *Xylaria* sections *Xylocoryne* Fries  
*Xylostyla* Fries  
*Xylodactyla* Fries.
- 13 (11) Perithecia not evident in outline though often few per stromal clava or clavula; if otherwise then the stromata terminate in definite excentric sterile apices; stromata are simple or branched, sessile or stipitate; clavata or clavulae pulvinate

- to obconic . . . . . 14.  
 13' Perithecia evident in outline, especially when  
 few to a stroma, but never developing sterile  
 apices . . . . . 15.  
 14. Stromata uniperitheciate or biperitheciate only.  
*Kretzschmaria* Fr. sect. *Stilbohypoxyton*  
 (Henn.) Martin.  
 14' Stromata consistently with several perithecia,  
 rarely uniperitheciate. (Conidial stage: *Acrostaphylus* on *Isaria*-type coremium).  
*Kretzschmaria* Fr. sect. *Eukretzschmaria*  
 Martin.  
 15 (13) Stroma without evident colouration, nor producing  
 a stain in acetone or alcohol; stromata with  
 one, few or many perithecia, vertically oriented  
 or occasionally diagonal but usually evident in  
 outline; basal tissue discoloured or white but  
 usually pale; ectostroma not coloured at maturity,  
 continuous; ostioles papillate; ascus plugs  
 cubic or rectangular. (Conidial stage: *Nodulisporium*,  
 sometimes on a *Graphium*-type coremium).  
*Hypoxyton* sect. *Entoleuca* (Syd.) Martin  
 syn. *Hypoxyton* subsect.  
*Primocinerea* Miller  
 Part *Penzigia* Sacc.  
 Part *Rosellinia* DN.  
 15' Stroma brightly coloured or producing a stain in  
 acetone or alcohol, if rarely failing this, then  
 ostioles are umbilicate and the stroma is corky  
 throughout; ascus plugs discoid or flattened.  
 (*Graphium*-type coremium present sporadically) 16.  
 16. Ostioles simple papillate. (Conidial stage:  
*Sporothrix*).  
*Hypoxyton* sect. *Papillata* Miller.  
 16' Ostioles truncate papillate. (Conidial stage:  
*Acrostaphylus*).  
*Hypoxyton* sect. *Annulata* Miller.  
 16'' Ostioles umbilicate, often wide and periphysate.  
 (Conidial stage: *Sporothrix*, or *Acrostaphylus*).  
*Hypoxyton* sect. *Euhypoxyton* Miller.

The rest of this work to be discussed in later papers amplifies the classification outlined here by reference to and discussion of the individual genera.

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**NOTES ON NUMERICAL ANALYSIS**  
**AS APPLIED TO VEGETATION**  
**CLASSIFICATION**

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Like other biological scientists, for a variety of reasons ecologists require some form of classification of their material. Basically any classification aims to order individuals into groups on the basis of their relationships and the theoretical study of classification has led to the discipline of taxonomy, which is concerned with the theory and principles of such grouping. In South Africa, as in many other countries, vegetation studies have included a number of basically very different systems of community classification and in recent years the application of so-called objective methods has received an increasing amount of attention. This paper aims to emphasize a few fundamental concepts in vegetation classification which may be considered by those who, while they may have little aptitude for mathematical theory, must decide on the most appropriate approach to classification in the field.

A detailed comparison of the approaches used in classification and ordination of vegetation has been made elsewhere (Roberts, 1966) and in the present discussion it is assumed that statistical methods are required if the desired level of efficiency is to be attained in the investigations concerned.

As the importance attached to objective, quantitative and statistical methods in ecology increases, so the dangers of the application of inappropriate mathematical procedures become more apparent. At the same time the scientific respectability which statistical treatment of the data presumably lends to quantitative investigations in no way guarantees the validity of the conclusions

reached. Indeed, the mere application of objective methods, which do no more than eliminate personal bias, will only give meaningful results if the statistical procedures used are suitable for the purpose at hand. Clearly what is required is:

- (a) an unbiased sampling technique;
- (b) the use of meaningful classification criteria;
- (c) the computation of end groups on the most appropriate basis.

Failure to meet any one of these basic requirements may invalidate the entire investigation and it is the appropriateness of the basis of grouping that is of primary interest in the present discussion.

If ecological investigation is to expose rather than impose groups or taxa, then new units must be recognized on the basis of either similarities or differences between individuals. Recognition and grouping of similarities gives what is referred to as agglomerative classification while grouping according to differences leads to a divisive classification. In addition, grouping may be based on either a single or on several attributes (e.g. species). Mathematical efficiency will largely determine which combination of the above alternatives is indicated, so that these primary decisions regarding choice of technique are basic to the ecological validity of the results obtained.

An example of divisive monothetic (single attribute) grouping is that of Williams & Lambert (1959) known as association analysis. It is claimed that this method gives what is probably the most efficient division of the vegetation because it is based on the most important floral discontinuities. In other words, it divides the plant population on the basis of those species which display the highest degree of association with all other species. The original method has been modified and extended to give a number of progressive stages in association analysis, e.g. nodal and inverse analysis (Williams & Lambert, 1961a). However, even in the more recent refinements of the method (Lance & Williams, 1965) the approach remains basically divisive and monothetic. Despite the disadvantages inherent in all monothetic methods, Greig-Smith (1966) regards Williams & Lambert's association analysis as the most satisfactory of the readily available classificatory techniques. Association analysis has been used by several workers in South Africa recently (van der Walt, 1962; Grunow, 1964; Miller, 1966) and the writer has discussed the practical application of the method when used as a basis for vegetation/habitat studies in the Orange Free State (Roberts, 1966).

In view of the increasing attention being paid to association analysis as a basic classificatory procedure, the limitations of this type of analysis as referred to by Ivimey-Cook and Proctor (1966) are worthy of note. These authors emphasize that the criterion of heterogeneity (highest  $X^2$  value) is not necessarily

indicative of population heterogeneity. Nor does division of the data necessarily indicate discontinuity, since the existence of any significant association within continuously distributed data will cause a division. The procedure sets a limit below which the remaining group of quadrats cannot be subdivided however heterogeneous they are. Dividing species are limited to those which actually occur in the data, although these may not necessarily be the best divisions. The hierarchical arrangement produced is not necessarily a hierarchy of relationship (Ivimey-Cook and Proctor, 1966). Recently the results obtained by association analysis have been compared with those obtained by other methods of classification as applied to actual field situations and close similarities between the groupings as given by association analysis and other methods of clustering have been shown (Anderson, 1966). Sokal and Sneath (1963) report a comparison of association analysis and a polythetic method using Sneath's coefficient of similarity (which forms clusters on the basis of single linkage of similarity values) when applied to data provided by Lambert from 56 quadrats. It was found that when nodal analysis (an extension of association analysis) was applied the dendrograms given by the two methods were very similar in differentiating most vegetation types. The same applied to the comparison with normal and inverse analyses (Williams & Lambert, 1961a). However, Sokal & Sneath point out that the polythetic method was "less sensitive to chance presence or absence in a quadrat of any single species". Thus in association analysis, in which clustering depends on the presence of a single species, a quadrat may occasionally be removed by classification, from quadrats which are very similar floristically.

Theoretically any monothetic system of classification will carry the risk of misclassifying units when natural phenetic groups are sought. Sokal and Sneath (1963) explain that this is because an organism (e.g. community) which lacks the all-important attribute (e.g. species) which is used to make the primary division, will always be assigned to a group far from the "required position", even though it closely resembles its natural neighbours in all other attributes. "The disadvantage of monothetic groups is that they do not yield natural taxa, except by a lucky choice of the feature used for division. The advantage of monothetic groups is that keys and hierarchies are readily made" (Sokal & Sneath, 1963).

In comparison, polythetic methods may be expected to yield more natural groupings because they cluster those units which have the greatest number of attributes in common. Nor is any one attribute sufficient or essential for membership of the group in a polythetic system. The polythetic divisive methods are at present computationally impractical (Greig-Smith, 1966) so agglomerative methods are indicated. Agglomerative methods all have the disadvantage that since they are built up from the lowest level, they often include much unwanted



data and are computationally slow. Natural taxa have been described as "sets composed of all those elements which share  $x$  or more features out of  $y$  features, where  $x$  and  $y$  are large numbers, but in which an element may have any combination of features as long as the total number of features shared with every other element of the set is  $x$  or more" (Sneath, 1961). To arrive at a natural classification the ecologist has to answer certain basic questions which have ecological rather than the statistical significance:

1. What material is to be classified?
2. What attributes should be used as classification criteria?
3. Should these criteria be weighted?
4. Should grouping be based on similarities or differences?
5. What method of clustering should be adopted?

While the details of procedure may depend largely on the aims of the investigation, a few alternative methods of classifying vegetation when presence and absence data are used to establish similarities may be considered. All forms of cluster analysis refer to numerical techniques used for defining groups of taxonomic units based on high similarity co-efficients and together with association analysis, the following have been suggested as efficient methods:

1. Single Linkage Clustering (Sneath, 1957).

This first clusters those individuals which are most closely related by the highest possible co-efficient of similarity. The level of similarity is then successively lowered, allowing more individuals to enter the original groups. Thus the taxonomic units A and B will combine when the co-efficient of similarity is say 0.9; when it is 0.8 taxonomic unit C joins A and B and when it reaches 0.7 unit D enters. The admission of one unit or cluster into another is by the criterion referred to as single linkage. However, chaining may occur when members at each end of a cluster have a relatively large taxonomic distance between them, although each is very close to its nearest neighbour. To overcome chaining, Sneath suggests re-calculating the mean similarity values both within and between clusters at any of a number of hierarchic levels.

2. Clustering by complete linkage.

This is Sorensen's (1948) method and corresponds to Sneath's method, except that the joining of a taxonomic unit to an existing cluster is on the basis of what is termed complete linkage. This implies that the unit concerned must display similarities to every member of the cluster and not just with one member as in single linkage. The type of clustering arrived at will obviously differ with different initial levels of similarity co-efficient.

3. Clustering by average linkage.

This approach is suggested by Sokal and Michener (1958) primarily for use with correlation co-efficient matrices but can be applied to various types of

similarity co-efficient matrices. Average linkage procedures base the admission of an individual into an existing cluster, on the average of the similarities of that individual with the members of the cluster.

In summarizing the comparison between clustering techniques Sokal and Sneath (1963) recommend average linkage at the present stage of development of numerical taxonomy. This procedure re-calculates the similarity co-efficient matrix at regular intervals as the classification develops. Rohlf (1966) supports this suggestion, adding that "... our recent results show rather clearly that the average linkage method (using arithmetic averages) is to be preferred on the basis of the fact that it results in classifications which show less distortion than when classifications are constructed by other means (such as single linkage or complete linkage cluster analysis)". Programmes for average linkage analysis are available at the Microbial Systematics Research Unit, University of Leicester, Leicester, England (Sneath, 1966) and at the Department of Entomology, University of Kansas, Lawrence, U.S.A. (Rohlf, 1966).

The Department of Statistics at Rothamsted Experimental Station has recently examined some of the present methods proposed for clustering and has compiled programmes for the classification of presence and absence data or quantitative data on plants and habitat (Orion Classification Programme CLASP). A second programme, which is still somewhat exploratory, has been developed primarily to compare clustering methods (Numerical Taxonomy Programme, NUT). Gower (1966) suggests that while association analysis may be useful for key-making, for general purpose classification the "Weighted Mean-Pair Group" method (Sokal & Michener, 1958) is recommended, using the authors' formula (3). Gower stresses however, that while the hierarchical structure imposed by cluster analysis is probably valid for differentiating between higher and lower taxonomic orders, when cross-classifications exist, some form of multivariate analysis is indicated.

In a recent contribution by Williams, Lambert and Lance (1966) several of the fundamental issues involved in the choice of classificatory procedure are admirably dealt with from the theoretical viewpoint. However, these authors point out the difficulty inherent in assessing the ecological acceptability of classificatory procedures. The difficulty is to select suitable "objective criteria in an essentially subjective situation by which to differentiate between the analyses". They add that within the test-communities, "the threshold for our acceptance of any of the hierarchical methods under study (including centroid sorting and information statistic) will be that the major groupings which arise shall not be fewer than, or markedly different from, *those recognised intuitively as distinct ecological entities* at the time the data were collected".

It would seem thus that some degree of subjective ecological integrity is

required in evaluating the various objective approaches to vegetation classification and thus in survey work and mapping, emphasizing the fundamental requirement of a broad ecological training for practising botanical survey staff. While this paper does not propose the use of one classificatory procedure to the exclusion of others it may throw some light on the real problems confronting the field worker, who is too often groping instead of grouping.

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## EUPHORBIA SPECIES FROM THE FLORA ZAMBESIACA AREA: VII.

L. C. LEACH

In 1962 Mr. J. A. Whellan gave to the writer some live plants of an unidentified dwarf Euphorbia which he had discovered near Abercorn in N.E. Zambia. These plants were obviously closely related to *Euphorbia isacantha* Pax, which was originally described "cyathiis et fructibus ignotis"; the consequently incomplete description made it difficult to determine the taxonomic status of the Abercorn plants, at least until *E. isacantha* were better known to the present author. N. E. Brown's more detailed description in Thistleton-Dyer, Flora Trop. Afr. 6, 1: 575 (1911) did give more grounds on which to base an opinion but there remained an element of doubt.

However, in 1965 some rooted cuttings of *E. isacantha* (Milne-Redhead and P. Taylor 8643A, from the Matengo Hills, Miyau, Tanzania) were received from Kew, there seems to be no doubt regarding the identity of these as they agree very closely with the published descriptions and the drawing of the type material of *E. isacantha* (the holotype, Busse 949, is assumed to have been destroyed but a drawing is preserved at Kew). It should, perhaps, be mentioned that the involucre of the Miyau plants are quite glabrous but this is not considered to be of any significance, particularly as the "minutely puberulous" involucre of N. E. Brown's description were from a loose cyme which may possibly not have belonged to Busse 949.

These cuttings were placed in cultivation in the author's garden at Nelspruit and have since flowered; it is consequently now possible to proceed with confidence with the publication of the new species.

### ***Euphorbia whellanii* Leach, sp. nov.**

*E. isacanthae* Pax affinis sed tota planta multo parviore; ramis paucioribus minus ramulosis subcylindricis, tuberculis prominentioribus verticaliter 5-7-seriatis; podariis haud decurrentibus; glandulis multo parvioribus transverse oblongis non contiguis foveolatis; stylis multo brevioribus differt.

*Fruticulus* pumilus spinosus succulentus glabrus basiramifer, ramis plerumque

simplicibus, valde confertis. *Rami* subcylindrici (valde sulcati in tempore sicco) tuberculati, ad 17.5 cm longi, 0.35–0.8 cm diam, *tuberculis* ad 1 mm altis, 5–7 plerumque 6-seriatis, verticaliter dispositis (ubi 5-seriatis saepissime in spiram contortis) 3–5 mm distantibus, *Folia* minuta, carnosae, deltoidea, c. 0.5 mm longa, inter spinas binas superiores disposita, mox decidua, cica-tricibus plus minusve late obovata. *Podaria* plus minusve obovata, 1–2 mm longa, haud decurrentia, 4-spinifera. *Spinae* binae divergentes  $\pm$  aequilongae, 2.5–3.5 mm longae, pare superiore suberecto et pare inferiore valde deflexo. *Inflorescentia* cymosa, cyathiis 3, horizontaliter dispositis (interdum cyathio bisexuali unico). *Cyma* perbrevis pedunculata, pedunculo bibracteato, 1.5–2.5 mm longo; bracteae deltatae truncatae denticulatae, c. 1 mm longae; cyathium primum masculinum mox deciduum aut interdum bisexuale persistens unicum; cyathia lateralia bisexualia, cymarum ramis brevissimis, 1.5–2.0 mm longis; bracteae subquadratae dentatae, c. 1.25 mm longae. *Involucrum* infundibuliforme glabrum, c. 2 mm longum, 3.5 mm diam glandulis inclusis; *glandulae* 5, carnosae patulae non contiguae, planae vel leviter convexae marginibus obtusis, transverse oblongae, 1.4–2.0 mm  $\times$  0.6 mm, minute foveolatae, flavae; *lobi* 5, plus minusve late cuneati, plerumque aliquantum emarginati, denticulati, c. 1 mm lati. *Flores masculini* 10–12, 5-fasciculati bracteolis latis fimbriato-laciniatis, c. 2 mm longis; pedicelli 2 mm longi; filamenta c. 0.5 mm longa. *Ovarium* sessile, 3-lobatum, subglobosum, perianthio 3-lobato, c. 1 mm diam; *styli* patuli, libri e basi, graciles, apicibus capitatis rugulosis integris, c. 1.5 mm longi. *Capsula* globoso-trilobata, sessilis, c. 4 mm diam, 2.5 mm alta, involucri reliquiis obris suffulta. *Semen* subglobosum, c. 1.75 mm  $\times$  1.5 mm, albidum parum fusco-maculatum, dense verrucosum, verrucarum forma et amplitudine variabilibus.

Type: *J. A. Whellan* 2122 (K; PRE; SRGH, holotype).

Note: The type material has, of necessity, been prepared over a period from plants of the original gathering, now in cultivation at Salisbury and Nelspruit.

ZAMBIA. Northern Prov., near Kawimbe Mission, approx. 8° 50' S, 31° 31' E, "in rock crevices with good humus, in association with *Aloe mzimhana* Christian", *Whellan* 2122 (K; PRE; SRGH).

This most interesting dwarf species is known only from the type locality near Kawimbe Mission, which is about 20 miles east of Abercorn, not far from the Zambian/Tanzanian border. Plants are here found growing in crevices on granite slopes "in rather damp situations and in partial shade" (in the writer's experience plants do not survive in cultivation in either Salisbury or Nelspruit unless copiously watered during long dry periods).





Small plant in cultivation at Nelspruit, ht. c. 10 cm.

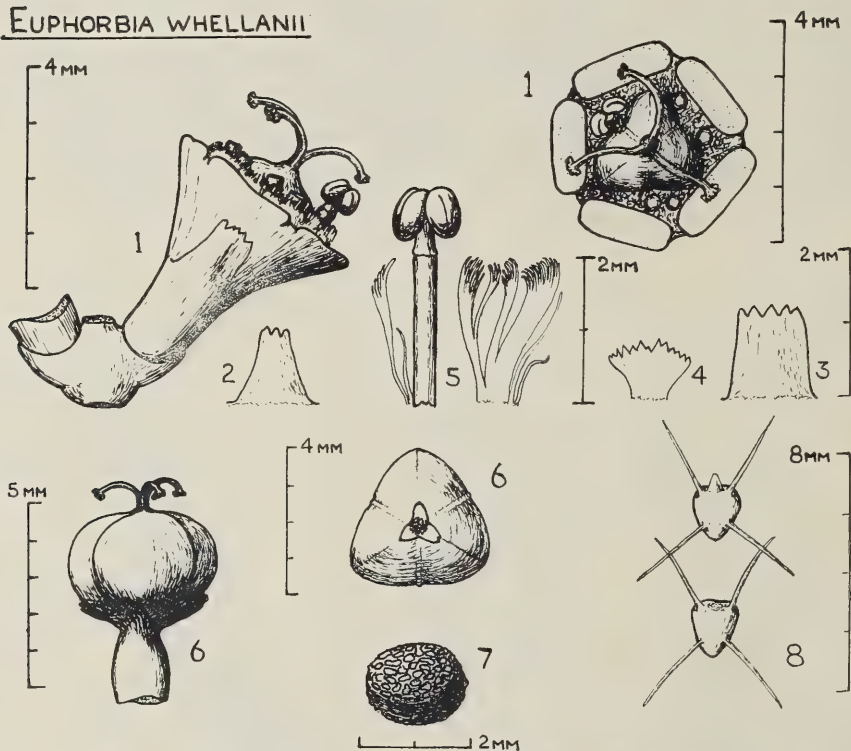


Flowering and fruiting branch apices.  
*Euphorbia whellanii* Leach

*E. whellanii* is, it seems, most closely related to *E. isacantha* Pax from which it differs in being very much smaller in all its parts, with fewer, less rebranched, more prominently tuberculate, subcylindric branches (those of *E. isacantha* are quadrangular) with the tubercles arranged in 5-7 (8) vertical ranks, whilst its smaller spine shields are not at all decurrent. The minutely pitted, transversely oblong, quite separate glands of *E. whellanii* are very different from those of *E. isacantha* which are closely contiguous and often connate; finally the styles of the new species are much shorter than are those of Pax' species.

*Plant*, a succulent, spiny, dwarf shrublet, generally only a few inches high,

### EUPHORBIA WHELLANII



1. Cyathium.
2. Peduncular bract.
3. Cyme branch bract.
4. Involucral lobe.

5. Male flower with bracteoles.
6. Capsule.
7. Seed.
8. Spinescence.

densely branched from the base, with the branches usually simple. *Branches* subcylindric tuberculate (deeply sulcate when suffering from drought), up to 17.5 cm long, 0.35–0.8 cm diam; tubercles up to 1 mm high, arranged 3–5 mm apart in 5–7 (8) vertical ranks (usually 6, when 5 then almost always spirally twisted). *Leaves* minute, deltoid, c. 0.5 mm long, soon deciduous leaving a more or less broadly obovate scar directly between the upper pair of spines. *Spine shields* more or less obovate, 1–2 mm long, not at all decurrent, bearing 4 spines. *Spines* 2.5–3.5 mm long, slender, whitish and rather fragile, arranged in divergent pairs of more or less equal length; the upper pair suberect and the lower strongly deflexed and often more widely divergent than the upper. *Inflorescence* a very shortly pedunculate cyme of three cyathia arranged in a plane at right-angles to the axis of the branch, sometimes reduced to a single bisexual cyathium; primary cyathium male deciduous or sometimes bisexual persistent; lateral cyathia always bisexual; *peduncle* bibracteate, 1.5–2.5 mm long; bracts deltate, truncate denticulate, c. 1 mm long; *cyme branches* very short, 1.5–2 mm long; bracts subquadrate dentate, c. 1.25 mm long. *Involucre* funnel shaped, glabrous, c. 2 mm long, 3.5 mm diam including the glands; *glands* 5, fleshy, spreading, distinctly separate, flat or slightly convex from the rounded margins, transversely oblong, 1.4–2.0 mm  $\times$  0.6 mm, minutely pitted, yellow; *lobes* 5, more or less broadly cuneate, usually somewhat emarginate, denticulate, c. 1 mm wide. *Male flowers* 10–12, in 5 fascicles, with broad fimbriate lacinate bracteoles c. 2 mm long; pedicels 2 mm long, filaments c. 0.5 mm long. *Ovary* sessile, 3-lobed subglobose with a 3-lobed perianth c. 1 mm diam; *styles* spreading, free to the base, slender, with the apices capitate rugulose entire. *Capsule* obtusely 3-lobed, sessile, c. 4 mm diam  $\times$  2.5 mm high, with the crushed and flattened remains of the involucre persisting at its base. *Seed* subglobose, c. 1.75 mm  $\times$  1.5 mm, whitish, slightly and irregularly marked with blackish brown, densely verrucose, with the verrucae somewhat variable in both shape and size.

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Agriculture, Salisbury, Rhodesia and now Senior Entomologist to the Government of Malawi, who has collected widely in southern tropical Africa and for whom the new species is now named, for living plants of *E. whellanii* as well as many other succulent plants from various localities.

When Pax described *Euphorbia griseola* in 1904 the species was known only from southern Botswana (Bechuanaland Prot.), but is now known to occur, albeit with a somewhat scattered distribution, as far north as Zambia and Malawi; it does, over this wide range and under the diverse ecological conditions encountered, comprise a very variable complex of almost dwarf plants to large shrubs of tree-like habit, the whole being united by identical floral and fruiting characters.

The present writer has studied this complex and the taxonomic problems involved over a number of years, both in the field and from plants in cultivation, and has reached the conclusion that it would be as unrealistic to "lump" it into one variable taxon as to recognise several groups at specific level.

Despite the difficulty which may sometimes be experienced in identifying herbarium specimens, other than through the locality, it is felt that two of the taxa concerned are so distinct from the typical small shrubs that some nomenclatural separation is desirable, especially as populations of these plants are often an important constituent of the communities of which they form a part. In view of their discrete distributions and the fact that the populations and especially the juveniles (particularly those of subsp. *mashonica*) are usually immediately distinguishable, recognition of these taxa at subspecific level seems to be the most logical course and has been followed in the ensuing treatment. Although this is unsatisfactory in some respects, as compromises are bound to be, it is considered to reflect the essentials of the taxonomic position, whilst avoiding the undue nomenclatural complication which would follow the recognition of numerous varieties and forms.

White, Dyer and Sloane (The Succ. Euphorb. 2: 775, 1941) suggested that plants from the Matopos Hills were likely to be more closely related to *E. heterochroma* Pax than to *E. griseola* and (*tom. cit.*: 781) tentatively identified specimens from northern Mashonaland with the former species; this view seems to have been accepted by subsequent writers.

However, *E. heterochroma* is essentially an East African species and differs from *E. griseola* in a number of characters. *E. heterochroma* is, in general, much less rebranched and rather more robust with more regularly 4-angled branches which are usually less prominently tuberculate; the leaf scars are more or less very broadly obovate or obtriangular but those of *E. griseola* are less distinct and more or less circular; the involucre and involucre glands are a different



shape and, most important of all, the seeds of *E. heterochroma* are verrucose whilst those of *E. griseola* are smooth. White, Dyer and Sloane (*tom. cit.*: 780) describe the seed of the former species as smooth but this is thought to be an error, based possibly on misidentified material from Rhodesia, as all seeds of *E. heterochroma* seen by the writer have been verrucose; that this is a specific character of this taxon has also been confirmed by Mr. P. R. O. Bally (personal communication).

A key to the subspecies follows:

Shrubs without or with very much reduced main stem:

Branches not or only slightly and distantly constricted, spine shields usually united into a continuous or subcontinuous horny margin, distributed mainly in Botswana, Rhodesia and Transvaal . . . . . subsp. *griseola*

Branches distinctly segmented, spine shields often distinctly separate and obovate in shape; distribution confined to Zambia and possibly the Congo (Leo.) . . . . . subsp. *zambiensis*

Shrubs of tree-like habit with a slender, many-angled central stem; distributed mainly in the north of Rhodesia. . . . . subsp. *mashonica*

***Euphorbia griseola*** Pax in Engl. Bot. Jahrb. **34**: 375 (1904).—N. E. Brown in Th. Dyer, Fl. Trop. Afr. **6**, 1: 578 (1911) and in Fl. Cap. **5**, 2: 364 (1915).—Burt-Davy, Fl. Pl. and Ferns Transv. and Swazil. **2**: 296 (1932).—White, Dyer and Sloane, Succ. Euphorb. **2**: 774 (1941).—Jacobsen, Handb. Succ. Pl. **1**: 436 (1960).—Goodier and Phipps, Chimanimani Check List, in Kirkia **1**: 58 (1961).—Type: Botswana (Bechuanaland Prot.), Lobatsi, *Marloth* 3413 (B†).

Neotype: Lobatsi, *Leach* and *Noel* 121 (BR; G; K; LISC; PRE; SRGH).

(The holotype material was probably destroyed in Berlin in 1943; as no duplicate has been located, *Leach* and *Noel* 121 has been selected as the neotype).

*Euphorbia griseola* Pax var. *robusta* Pax ex Engler, in Pflanzenformat. Transv. and S. Rhod., Sitz and Preuss, Akad. Wiss. Berl. **52**: 881 (1906), nom. nud.—ex Eyles in Trans. Roy. Soc. S. Afr. **5**: 398 (1916), nom. nud.

(This variety was based on the specimen *Engler* 2860B from the Matopos, Rhodesia: for description see N. E. Brown, in synonymy under *E. griseola*, *loc. cit.*).

*Euphorbia heterochroma* sensu White, Dyer and Sloane, *tom. cit.*: 780, pro parte quoad distrib. Rhodesia et fig. 873 (1941).—sensu Wild, Dict. Pl. Names: 83 (1952).

*Euphorbia ledienii* sensu Suesseng. apud Suesseng. and Merxm. in Trans. Rhod. Sci. Ass. **43**: 84 (1951).

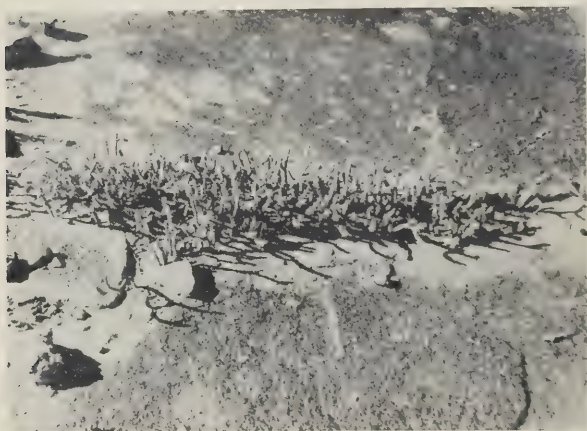
#### Subsp. *griseola*

Small shrubs or undershrubs, generally less than 1 m high, with 4/6-angled branches and branchlets which are not or only slightly constricted at distant intervals, with continuous or subcontinuous horny margins which are only very

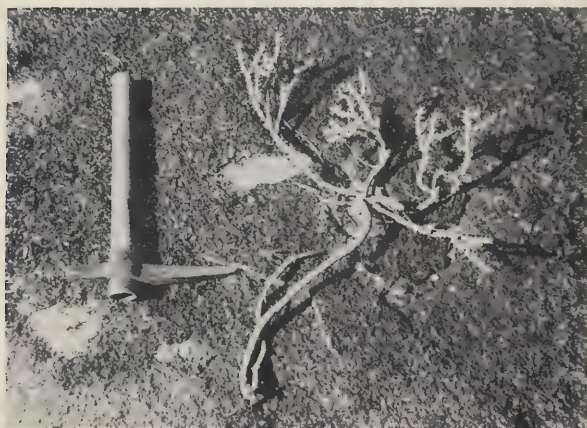




Typical seedling from  
Matopos Hills, Rhodesia.  
*Coll. Mrs. E. J. Bullock.*



Rhizomatous dwarf  
plants near  
Chibi, Rhodesia.  
*L. C. Leach 9314.*



Subsp. *griseola*

rarely, regularly interrupted at the flowering eyes. Main stem absent or reduced to a mere "crown".

BOTSWANA. N:  $\pm$  50 mls. N, Francistown, *Leach* and *Noel* 27 (K; PRE; SRGH); Totome, prope Francistown, *Lamont* s.n. in *Leach* 11704 (PRE). SE: Lobatsi, *W. J. Louw* s.n. (PRE; SRGH); 2 mls. N, Lobatsi, 16.i.1960, *Leach* and *Noel* 121 (BR; G; K; LISC; PRE; SRGH); Notwani, *J. Knobel* s.n. (PRE); 8 mls. S, Gaberones, 19.i.1960, *Leach* and *Noel* 219 (PRE; SRGH; ZSS).

RHODESIA. N: Mrewa, Chibakwe Riv., fl. 23.vii.1959, *Leach* 9233 (K; PRE; SRGH);  $\pm$  5 mls. N, Mrewa, fr. 23.vii.1959, *Leach* 9235 (K; PRE; SRGH; ZSS). W: Matopos, *Marloth* 6194 (PRE), *Mogg* s.n. (PRE), *Plowes* 1380 (SRGH), "Besna Kobila", *Miller* 4574 (PRE; SRGH), *Miller* 6009 (SRGH), "Siloswe koppie", *Ferrari* s.n. (PRE); Plumtree, *Van Son* s.n. (PRE). C:  $\pm$  5 mls. SE, Inyazura, fr. xii.1956, *Leach* 5141 (CAH; G; K; PRE), *ibid.* *Leach* 9833 (PRE; SRGH), *ibid.* fl. fr. 24.ix.1965, *Leach* and *Müller* 13138 (BM; BR; K; PRE; SRGH; ZSS); Marandellas Distr., *Dehn* 681 (fig. SRGH); Rusapi, Chiduku Res., *Plowes* 2467 (PRE; SRGH). E: prope Bonda Mission, *Leach* 10772 (K; PRE; SRGH); Sabi/Lundi Riv. Junction, *Plowes* 2466 (G; K). S:  $\pm$  5 mls. W, Beitbridge, *Leach* 11585 (G; K; LISC; PRE; SRGH);  $\pm$  2 mls. S, Chibi Village, *Leach* 9314 (PRE; SRGH); prope Zimbabwe, fr. 12.i.1961, *Leach* 10711 (BM; BR; G; K; LISC; PRE; SRGH); Kyle Dam, 5.xii.1960, *Leach* 10557 (PRE); "Igar" prope West Nicholson, *Leach* and *Bullock* 13323 (PRE; SRGH).

REP. S. AFRICA. Transvaal: Waterberg Distr.: 23°S, 27°E, prope Elmoston, *Codd* and *Erens* 4017 (PRE; SRGH); Riebeeck W., *Van der Merwe* 1752 (PRE); 24°S, 27°E,  $\pm$  5 mls. NW, Rooiberg, *Leach* and *Bayliss* 11192 (SRGH); Rooiberg-Matlabas road, *Holloway* 493 (PRE); 24°S, 28°E, 7 mls. NE, Nylstroom, *A. O. D. Mogg* 16613 (PRE). Rustenberg Distr.: 24°S, 27°E, Krantzberg, *I. B. Pole-Evans* 2381 (PRE), *ibid.* *Dyer*, *Verdoorn* and *Erens* 4203 (PRE); "Kareehoek", *L. E. Codd* 3751 (PRE), *ibid.* *Van der Merwe* 1692 (PRE); 24°S, 27°E, prope Thabazimbi, *Van der Merwe* s.n. (PRE). Pretoria Distr.: 25°S, 28°E, Rust der Winter, *R. A. Dyer* 3978 (PRE).

MOÇAMBIQUE. Z: Ile Mts., *Torre* 5695A (LISC). MS: "The Corner", Chimanmani Mts., *Phipps* 841 (SRGH).

MALAWI. S: prope Ntaja, fl. 10.viii.1960, *Leach* 10419 (K; LISC; PRE; SRGH).

The typical subspecies is widely distributed in somewhat scattered colonies which exhibit a considerable degree of variation, both in habit and in vegetative characters.

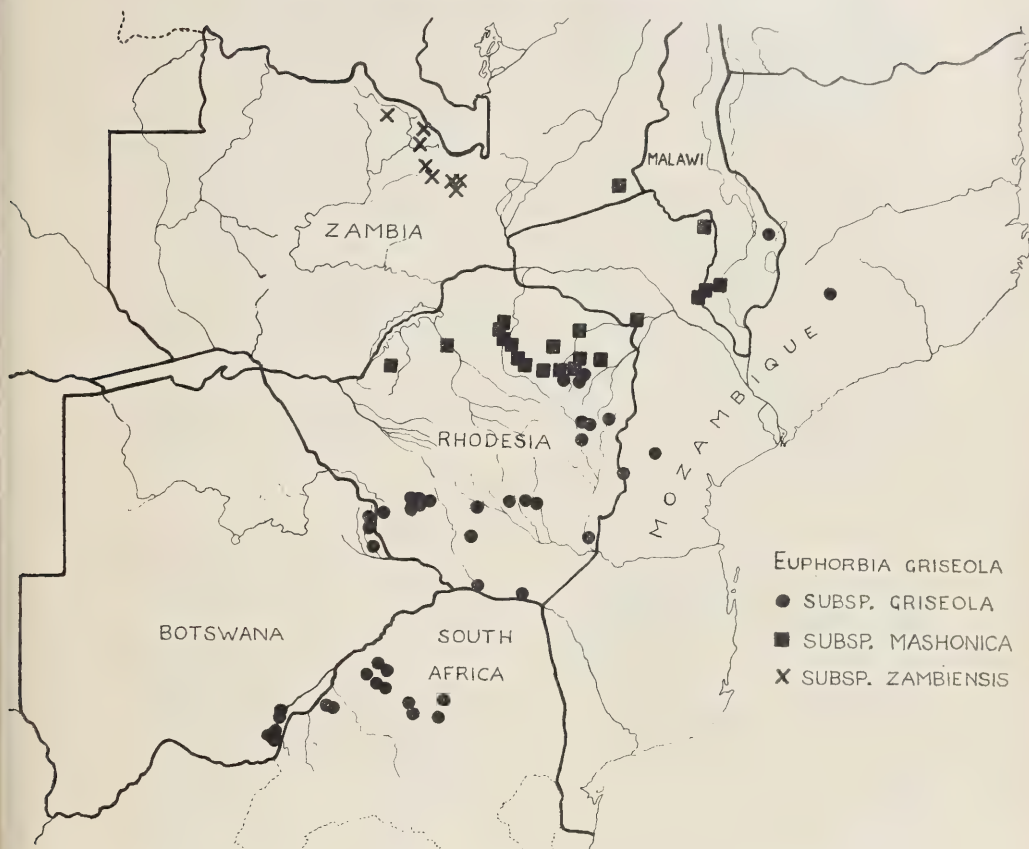
At the type locality near Lobatsi and elsewhere in southern Botswana plants

form densely ramose shrubs up to c. 1 m high (usually less) with the branches not at all, or rarely, slightly constricted into segments and with the horny margins quite continuous or very rarely interrupted at the flowering eye. North-east of Francistown, towards the Rhodesian border, specimens are taller (up to 2 m), more sparingly branched and rebranched with the branches constricted at distant intervals; another isolated colony, more typical in habit is to be found on sandstone rocks on the north bank of the Limpopo Riv. some 5 miles west of Beitbridge.

The taxon is rather sparsely represented in the Transvaal where plants sometimes adopt a more spreading, partially prostrate habit. Scattered colonies occur throughout the granite hills of the Matopos in Matabeleland, here plants are slightly more robust than those at the type locality and appear to have been considered by Pax as being distinct at varietal level, however, when the species as now defined is viewed as a whole it seems that no taxonomic recognition is warranted.

The distribution of subspecies *griseola* continues in a rather disjunct series of populations along the granite hills and domes stretching more or less east and north-east from the Matopos. There are a few very isolated populations in mountainous areas of Moçambique and Malawi which seem to belong here but complete information regarding these is, as yet, lacking. Of these the colony near Ntaja, to the south-east of Fort Johnston in Malawi, merits mention as the inflorescence is entirely dark purplish red whilst the plants, although apparently somewhat depauperate, otherwise seem to agree closely with the typical form, as do those from the Chimanimani Mountains which also bear dark crimson inflorescences; it may well be that on further investigation these as well as plants from the Ile Mts. and others growing on Mt. Zembe, both in Moçambique, will be found to be taxonomically distinct, meanwhile they have been included in the writer's concept of subspecies *griseola*. Another noteworthy form occurs just south of Chibi Village in Rhodesia, in which the semi-dwarf plants, generally less than 30 cm high, have relatively slender, not at all constricted, usually simple branches with conspicuous whitish horny margins and often develop a rhizomatous habit.

Near Mrewa and elsewhere in northern Mashonaland where populations of subspecies *griseola* and *mashonica* are occasionally found in close proximity, plants often adopt a more spreading habit which exposes the much reduced, few-angled main stems ("crowns" would perhaps be a better description) from which the branches arise. Plants from near Inyazura are generally of this pattern and also often produce much larger more spatulate leaves than are to be found elsewhere. Plants of similar habit but with rather more robust branches occur at scattered points along the Sabi River.



Subsp. **mashonica** Leach, subsp. nov.

*Euphorbia griseola* sensu Boughey, Check List Trees S. Rhod. in Journ. S. Afr. Bot. **30**: 162 (1964).

A subspecies typica habitu arboreo multo altiore; trunco centrali multiangulato aliquantum exili; ramis ramulisque verticillatis ascendentibus erectis differt.

TYPE: Mazoe Distr., Rhodesia, *L. C. Leach* 5019 (B; BM; BR; G; K; LISC; LMJ; M; NDO; PRE; SRGH, holotype; ZSS).



RHODESIA. N:  $\pm$  2 mls. NE, Mtoko, *Leach* 9245 (PRE; SRGH);  $\pm$  10 mls. NE, Mrewa *Leach* 9256 (K; PRE; SRGH); Umfurudzi/Mazoe Riv. Junction, fl. 7.viii.1959, *Leach* 9267 (BM; K; M; PRE; SRGH; ZSS); Umvukwes, Ruorka Ranch, *Wild* 3962 (SRGH); Darwin Distr. Unsengedzi Riv., *Wild* 3997 (SRGH);  $\pm$  35 mls. E, Mt. Darwin, 8.viii.1959, *Leach* 9290 (PRE; SRGH); Mazoe Distr.,  $\pm$  12 mls. NNW, Concession,  $\pm$  17° 18' S, 30° 50' E, cult. "Farview", fl. fr. *Leach* 5019 (B; BM; BR; G; K; LISC; LMJ; M; NDO; PRE; SRGH; ZSS), *ibid.* *Leach* 9514 (PRE); Angwa Riv. inter Mangula et Miami, fl. 5.vii.1964, *Jacobsen* (PRE); Umvukwes, "Andrew's Farm", *Eyles* 5449 (SRGH); Mazoe, *Eyles* 585 (SRGH); Ganderowe Falls, Sanyati Riv., W. bank, fl. 4.vii.1961, *Leach* 11170 (BR; G; K; LISC; PRE; SRGH); Sebungwe Distr., Ngolongolo Gorge, *Whellan* 536, (SRGH), *idem*, cult, *Leach* 9515 (PRE; SRGH). C: Chinamora Res. Domboshawa, *Eyles* 5160 (SRGH); *Loveridge* 1186, 1187 (SRGH); "Mawenga" *Simon* 969 (SRGH); Arcturus Distr. "Ewanrigg" *Christian* 5, 6 and 457 (PRE); Cleveland Dam, *Brain* 9517 (SRGH).

MALAWI. S: Mpatamanga Gorge, Shire Riv., *Leach* 9924 (K; PRE; SRGH);  $\pm$  3 mls. E, Mwanza, *Leach* 5088 (PRE).

MOÇAMBIQUE. T: Mazoe Riv. prope Rhodesian Border, *Whellan* s.n., 21931 in SRGH (SRGH); Angónia, Vila Mousinho, *Gouveia* and *Pedro* 1869 (LMJ); Zóbuè Mts., *A. R. Torre* 5754 (LISC).

ZAMBIA. E: Nzadzu Riv., *Robson* 23 (PRE; SRGH).

Subspecies *mashonica* may be immediately distinguished from the other taxa in the complex by its rather slender, many-angled (9–12) main stem and its much taller tree-like habit. Plants often attain a height of 3·5 m or more although usually somewhat smaller; under certain conditions a few trunk-like spreading branches are developed, usually from near the base of the trunk and so show a slight reversion to the shrubby form while in other cases the trunk is covered with a dense mass of spiny shoots which give the trunk an appearance of stoutness, emphasising the tree-like aspect.

Individuals lacking a main trunk but developing several trunk-like branches and occasionally developing into large densely ramose shrubs up to 4 m in diameter are considered to be best referred to subsp. *mashonicai*, although to some extent intermediate, this habit may have been due to damage to the growing point of the main stem in its juvenile state. Northward towards the Zambesi escarpment plants tend to become less densely and more divaricately branched; they then bear a superficial resemblance to the arborescent forms of the related polymorphic species *E. persistentifolia* Leach, which occurs on the Southern escarpment.

Towards the limit of distribution, to the north-east in Moçambique and





Plant in open, with densely branched head. Ht.  $\pm 2.6$  m.



Slender stemmed specimen in tree shade. Ht.  $\pm 3.3$  m.



Typical seedlings showing early development of multi-angled stem.



Apex of flowering branch. Hort. Greendale.

Subsp. *mashonica*  
*L. C. Leach* 5019, Type locality



Typical plant. Ht.  $\pm 0.7$  m.



Branch with separate obovate spine shields.

*Leach & Williamson 13548, N of Kapiri Mposhi.*



Typical Plant. Ht.  $\pm 2$ m.



Flowering branch. Hort. Greendale.

Subsp. *zambiensis*  
*Leach & Brunton 10019, Type locality*

Malawi, plants tend to be of smaller, less arborescent stature and to be more randomly branched. A gathering by Robson from Nzadzu Riv., south-west of Fort Jameson in the Eastern Province of Zambia, is of this pattern.

In many parts of northern Mashonaland these slender stemmed shrubs represent a significant proportion of and are a characteristic feature of the vegetation of the granite hills and kopjes to which they appear to be specially adapted (probably by reason of fire tenderness).

Subsp. **zambiensis** Leach, subsp. nov.

A subspecies typica ramis paucioribus crassioribus in segmentis distinctis constrictis; saepe podariis obovatis nonconfluentibus differt.

TYPE. Zambia, Central Prov., Kapiri Mposhi,  $\pm 13^{\circ} 45' S$ ,  $29^{\circ} 03' E$ , *Leach* and *Brunton* 10019 (K; LISC; NDO; PRE; SRGH, holotype).

ZAMBIA. W: Chingola, *Fanshawe* 3821 (NDO); C: Kapiri Mposhi, *Fanshawe* 7148 (NDO);  $\pm 35$  mls. E, Kapiri Mposhi, *Leach* and *Brunton* 10019 (K; LISC; NDO; PRE; SRGH); Mkushi Boma, *Williamson* s.n. in *Leach* 13537 (BM);  $\pm 18$  mls. N, Kapiri Mposhi, *Leach* and *Williamson* 13548 (BR; G; LISC; M; ZSS).

The distribution of this taxon appears from the records to be restricted to Zambia but its occurrence in neighbouring parts of the Congo seems probable.

As may be seen from the photographs, plants at the type locality, between Kapiri Mposhi and Mkushi Riv., with their distinctly segmented stouter branches and often with nonconfluent obovate spine shields, differ markedly from the typical *E. griseola* and would probably be considered to be distinct at specific level were it not for the identical flowering and fruiting characteristics and the similarity existing between occasional individuals in the Copperbelt area and plants of the typical subspecies from the Matopos Hills.

NOTE. In locating the cited specimens geographically, two systems have been followed:

- (1) The divisions of the Flora Zambesiaca area as shown on the map accompanying Vol. 1 of *Flora Zambesiaca* (1960), for those records falling within the area (Botswana, Malawi, Moçambique, Rhodesia and Zambia).
- (2) The Magisterial Districts with the addition of the approximate Lat. and Long., indicating the 1° square in which the specimen is sited, for localities within the Republic of South Africa.

The localities plotted on the distribution map include, as well as those cited, a few known to the author but for which no herbarium records are known.

#### ACKNOWLEDGEMENTS

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# NOTES ON THE NOMENCLATURE OF LEUCOSPERMUM R.BR. PART I.

J. P. ROURKE

(Compton Herbarium, Kirstenbosch)

## ABSTRACT

Eight new combinations in *Leucospermum* are proposed. *Leucospermum bolusii* Gandoger is an earlier name for *L. album* Bond, and *L. bolusii* Phillips is synonymous with *L. cordifolium* (Salisb. ex Knight) Fourcade.

During the course of revising *Leucospermum* it has become apparent that several changes in nomenclature are necessary. This paper sets out to publish some of the new combinations that must be made in order to bring the nomenclature of *Leucospermum* up to date, and to draw attention to those names and combinations already published, which have been overlooked in the past.

***Leucospermum cuneiforme*** (Burm. f.) Rourke, comb. nov.

*Leucadendron cuneiforme* Burm. f., Fl. Cap. Prodr.: 4 (1768)—basionym.

*Leucospermum attenuatum* R.Br. in Trans. Linn. Soc. Lond. **10**: 96 (1810).

N. L. Burman described *Leucadendron cuneiforme* in his "Florae Capensis Prodomus", p. 4 (published as a supplement to his Flora Indica), as follows: "foliis ovato-cuneiformibus scabriusculis, apice calloso tricuspidato, capitulis terminalibus sericeis." From the description of the leaves it was established that the plant described was a *Leucospermum*, the identity of which has always been uncertain. Phillips and Hutchinson did not examine the Burman herbarium when they monographed the Proteaceae for the Flora Capensis, and so they listed this species under the genus *Leucadendron* as "imperfectly known".

During the latter half of 1966 I was able to examine the Proteaceae in the Burman herbarium, when this collection was sent on loan to Kirstenbosch. Although unlabelled, it was not difficult to pick out the type of *L. cuneiforme* as it is the only Proteaceous plant newly described by Burman in 1768, and represented in his herbarium, that has tridentate cuneiform leaves, since all the other species described by him have entire leaves. Moreover, in the brief type description, the diagnostic phrase "apice tricuspidato" is used, and in the equally brief description on the sheet (in Burman's own hand) he uses the words





PLATE 1.

Holotype of *Leucospermum cuneiforme* (Burm. f.) Rourke in the Burman collection, Herb. Delessert, Conservatoire et Jardin Botanique, Geneva (G).



“apice trifido”. This concurrence of the diagnostic character mentioned in both the type description and in the note on the sheet is clear proof that the specimen in question is indeed the type of *Leucadendron cuneiforme* Burm. f.

***Leucospermum vestitum*** (Lam.) Rourke, comb. nov.

*Protea vestita* Lam., Encycl. Meth. Bot. Illustr. **1**: 239 (1792)—basionym.

*Leucospermum medium* R.Br. in Trans. Linn. Soc. Lond. **10**: 97 (1810).

*Leucospermum incisum* Phillips in Kew Bull. **1910**: 331 (1910).

***Leucospermum alpinum*** (Salisb. ex Knight) Rourke, comb. nov.

*Protea alpina* Salisb. ex Knight in Knight, Cult. Prot.: 27 (1809)—basionym.

*Leucadendron cartilagineum* R.Br. in Trans. Linn. Soc. Lond. **10**: 67 (1810).

*Leucospermum cartilagineum* (R.Br.) Phillips, in Dyer Fl. Cap. **5** (1): 636 (1912).

The academy of Natural Sciences, Philadelphia (PH), possesses a considerable number of specimens of South African Proteaceae collected at the Cape by James Niven, 1798–1803. Two isotype sheets of *Leucospermum alpinum* were discovered in this collection when it was on loan to Kirstenbosch in 1966. Both bear tickets in Niven’s hand one of which reads “*Protea* 3 or 4 ft high on the high peak of Khamiesberg”. This phrase is used verbatim in the type description and must have been copied word for word from Niven’s field ticket.

***Leucospermum saxatile*** (Salisb. ex Knight) Rourke, comb. nov.

*Leucadendrum saxatile* Salisb. ex Knight in Knight, Cult. Prot.: 58 (1809)—basionym.

*Leucospermum diffusum* R.Br. in Trans. Linn. Soc. Lond. **10**: 104 (1810).

***Leucospermum gracile*** (Salisb. ex Knight) Rourke, comb. nov.

*Leucadendrum gracile* Salisb. ex Knight in Knight, Cult. Prot.: 59 (1809)—basionym.

*Leucospermum stenanthum* Schlechter in Bot. Jahb. **27**: 112 (1900).

***Leucospermum truncatulum*** (Salisb. ex Knight) Rourke, comb. nov.

*Leucadendrum truncatulum* Salisb. ex Knight in Knight, Cult. Prot.: 61 (1809)—basionym.

*Leucospermum buxifolium* R.Br. in Trans. Linn. Soc. Lond. **10**: 100 (1810).

***Leucospermum heterophyllum*** (Thunb.) Rourke, comb. nov.

*Protea heterophylla* Thunb., Diss. Prot.: 24 (1781)—basionym.

*Leucospermum patulum* R.Br. in Trans. Linn. Soc. Lond. **10**: 100 (1810).

***Leucospermum truncatum*** (Meisn.) Rourke, comb. nov. et stat. nov.

*Leucospermum truncatum* Buek, in Drège, Zwei Pfl. Docum.: 123, 199 (1843) nom nud.



PLATE 3.

Isotype of *Leucospermum alpinum* (Salisb. ex Knight) Rourke in the herbarium of the Academy of Natural Sciences, Philadelphia (PH).

*Leucospermum zeyheri* Meisn. var. *truncatum* Meisn. in DC., Prodr. **14**: 256 (1856)—basionym.

Buek applied the name *Leucospermum truncatum* to a collection made by Drège on the limestone hills between Cape Agulhas and Potteberg. As no description was published, *L. truncatum* Buek is a nomen nudum. Several years later, Meisner adopted the epithet "truncatum" for a variety of *Leucospermum zeyheri* Meisn., citing Buek's nomen nudum and giving a complete latin description. In 1901, Gandoger published a description of "*Leucospermum truncatum* β. *septemdentatum* Gandoger". (In Bull. Soc. Bot. Fr. **48**: 95 1901). However, the binomial *Leucospermum truncatum* was used without any reference to a previously published description or diagnosis and therefore cannot be regarded as having been validly published under article 32 of the International Code of Botanical Nomenclature. Consequently, this has necessitated the making of the above combination.

#### THE CORRECT APPLICATION OF THE NAME *LEUCOSPERMUM BOLUSII*,

There has been some confusion regarding the correct application of the name *Leucospermum bolusii*. A collection made by Bolus at Gordon's Bay was described as *Leucospermum bolusii* by Gandoger in 1901. (*Bolus* 8077, isotype in BOL). Phillips (Fl. Cap. **5** (1): 634 1912), failed to recognise this very distinct species and included it in the synonymy of *Leucospermum puberum* (L.) R.Br. Consequently, when further material was collected from Gordon's Bay, Bond (1941), thinking this species to be unnamed, described it as *Leucospermum album* Bond. (Mathews NBG 1327/29, holotype in NBG).

*Leucospermum bolusii* Phillips, described in 1910, is synonymous with *L. cordifolium* (Salisb. ex Knight) Fourcade, and is in any case an illegitimate name and must be rejected since it is a later homonym of *L. bolusii* Gandoger.

***Leucospermum bolusii*** Gandoger in Bull. Soc. Bot. Fr. **48**: 95 (1901).

*Leucospermum album* Bond, in J. S. Afr. Bot. **7**: 200 (1941).

***Leucospermum cordifolium*** (Salisb. ex Knight) Fourcade, in Trans. Roy. Soc. S. Afr., **21**: 97 (1932).

*Leucadendrum cordifolium* Salisb. ex Knight in Knight, Cult. Prot.: 54 (1809).

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# THE GENUS *LIPARIA* L. (PAP.)\*

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## ABSTRACT

The genus *Liparia* consists of two species, *L. splendens* (Burm. f.) J. J. Bos et de Wit comb. nov., and *L. parva* Vog. ex Walp.; the former species is divided into two subspecies. Several proposed species are reduced to synonymy. The identity of *Leucadendron splendens* Burm. f. as disclosed by De Candolle is supported. Genus and species are described and illustrated; historical notes and a key are included.

## INTRODUCTION

*Liparia* L. is the type-genus to the subtribe *Lipariae* in the tribe *Genisteeae* (*Papilionaceae*).

The genus is endemic to the extreme south-western part of the Cape Province, Republic of South Africa. *Liparias* are showy flowering shrubs and subshrubs, rapidly becoming rare members of the typical "fijnbos" vegetation; they are among the protected wild flowers of the Cape.

Notwithstanding its rather singular appearance (at first sight *Liparia* seems proteaceous rather than papilionaceous) and other interesting characters, the genus never before seems to have been subject to a monographical study.

## HISTORICAL NOTES

The first reference in literature concerning *Liparia* appeared in 1704, in John Ray's *Historia Plantarum* (III, "Dendrologia": 107 n. 65) where the author gives a short description preceded by the phrase name: *Genista africana rusci foliis* etc. Ray indicates Sherard as the source of his material. This implies the still earlier introduction of the plant in Sherard's gardens, where it probably was raised from seeds. Its attractive habit and its distribution which includes the sites of the earliest settlements at the Cape, account for the early dispatch of its seeds to European conservatories.

The first nomenclaturally legitimate publication occurred when N. L. Burmann published *Prodromus Flora Capensis* (1768). He described *Leucaden-*

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\**Primitiae Africanae* VII.

*dron splendens* with a Latin phrase (*l.c.*: 4); thereby the taxon was placed in *Proteaceae*, an unexpected error after Ray's correct classification. *Prodromus Flora Capensis* was based on the collection of Cape plants owned by J. Burmann, his father. Previous to the publication of *Prodromus Flora Capensis* (1760) Burm. f. visited Linnaeus and showed him his father's plants for identification purposes.

Many of these plants were new to science and Linnaeus described, and subsequently published them, mainly in the *Mantissa* of 1767. However, the first publication of *Liparia* L. as a new genus is to be found in the second *Mantissa* of 1771 where an extensive generic description is given and several species are described. Presumably, Linnaeus gave the name *Liparia* because of the waxy or fatty surface of the leaves or, possibly, on account of the silky gloss of the yellow flowers (Greek: *liparos* = fatty, or also, shiny).

Six species are placed in *Liparia* L. by Linnaeus but only two are described in detail, the remaining 4 are each provided with one single phrase.

Of the two species of *Liparia* described in detail, one, *L. graminifolia* L. was probably based on material sent to Linnaeus by Ryk Tulbagh, Governor of the Cape, but the source of *L. sphaerica* L., designated by Linnaeus as the most typical species of the new genus, is not so easy to establish. Judging from the elaborate description, Linnaeus must have had at his disposal ample flowering and fruiting material, which might have been provided by plants cultivated in a conservatory. As a reference (he ignores Burmann's publication of *Leucadendron splendens*), Linnaeus mentioned Ray's description (*l.c.*) which is not illustrated.

In the Linnean herbarium there are two flowering specimens named *Liparia sphaerica*, but both names are in the handwriting of Linnaeus the younger. The keen interest of Linnaeus in this new genus is illustrated by the announcement of the publication of the second *Mantissa* in the Stockholm paper *Lärda Tidningar* (no. 81 *d.d.* 17 October 1771) where Linnaeus selects a few major novelties from *Mantissa altera* including: "*Liparia sphaerica*, en af de wäckraste växter från Cap. Bon. Spei;!" (one of the most beautiful plants of the Cape of Good Hope; *cf.* Stearn, 3 prefaces of *Lin. & R. Br.*, 1962).

Lamarck did not accept *Liparia* L. and included *Liparia* in *Borbonia* L. (*cf.* *Enc. Méth. Bot.* 1 (2): 435-438 (1783)).

Afterwards several new species in *Liparia* were proposed, mainly by Thunberg (*Prod. Fl. Cap.*: 123-124 (1794-1800)). De Candolle studied the generic delimitation once more in 1825 and excluded all but one of the proposed species, maintaining *Liparia* L. as a monotypic genus, represented by *Liparia sphaerica* L. (DC., *Mém. Fam. Leg.*: 190 etc. (1825)). The excluded species, De Candolle united into a new genus *Priestleya* DC. which was composed of 4 of the remain-

ing *Liparia* species published in Mantissa altera (the fifth being transferred to *Rafnia* Thunb.), of all 10 new proposed *Liparia* species by Thunberg (in Prod. Fl. Cap. l.c.), and of still 3 other species, proposed by Steudel, Andrews, and Sieber respectively. Of 2 remaining *Liparia* species referred to in literature, *L. hirsuta* Moench. (Meth. Pl. suppl.: 52 (1802)) was transferred to *Borbonia* L. while *L. badocana* Blanco (Fl. Filip. 1st ed. 1837, p. 597) turned out to be *Psoralea badocana* (Blanco) Blanco (Fl. Filip. 2nd ed.: 416 (1845); cf. Merrill, Enum. Phil. Fl. Pl. 2: 277 (1923)).

When publishing and delimiting *Priestleya* DC., De Candolle also established the identity of *Leucadendron splendens* Burm. f., mentioned before. De Candolle wanted to explain the unusual habit of *L. sphaerica* L. which made Burm. f. refer his specimen to *Proteaceae*. De Candolle established the fact that *Leucadendron splendens* Burm. f. and *Liparia sphaerica* L. were conspecific, of which he convinced himself by examining the type in Burmann's herbarium (DC. l.c.: 192).

Unfortunately the only specimen of *Liparia* (*Leucadendron*) *splendens* that exists today in the herbarium Burmann (G) was remounted at some later date, and has nothing to prove it to be the type of *Leucadendron splendens* Burm. f.

Although it is most regrettable that the type of *Leucadendron splendens* Burm. f. is no longer (with certainty) available, De Candolle's clearly expressed identification and discussion, added to his specialist study and knowledge of the group and to the unique and unmistakable appearance of *Liparia*, leave no reasonable doubt. Remounting Burmann's *Leucadendron splendens* may have caused the loss of the original label. Since *Leucadendron splendens* Burm. f. has priority, the new combination *Liparia splendens* (Burm. f.) J. J. Bos et De Wit is necessary.

After De Candolle's study several new species were proposed; their status and identity is explained further in the present revision.

It is to be noted that the Linnean type species occurs under the name *L. sphaerica* in all current literature and the earlier name, *Leucadendron splendens*, is not mentioned. De Candolle's findings of 1825 were almost completely overlooked by later authors, who appear to have followed earlier publications without any further research; G. Don, however, cited DC.'s statement in 1832 (l.c.: 131).

In the present paper, I have accepted De Candolle's concept of the genus. Owing to the kind help of numerous institutes and persons I was not only able to study *Liparia* in the field, but also to examine practically all specimens preserved in herbaria.

The year spent at Stellenbosch I remember with gratitude.

## LIPARIA L.

*Linn.*, Mant. II: 156 (1771); *Murray*, Syst. Veg. ed. XIII: 554 (1774); *Reichard*, Gen. Plant. ed. VII: 337 (1778); *Houttuyn*, Syst. Plant. IV: 238 (1779); *Reichard*, Syst. Plant. ed. Nov., III: 479 (1780); *Lamarck*, Enc. Méth. Bot. 1, 2: 435 (1783) (as part of *Borbonia*); *Murray*, Syst. Veg. ed. XVI: 665 (1784); *Jussieu*, Gen. Plant.: 535 (1789); *Necker*, El. Bot. III: 29 (1790); *Schreber*, Gen. Plant. ed. VIII, II: 499 (1791); *Gmelin*, Syst. Nat. ed. XIII, II: 1113 (1791); *Giseke*, Praelect.: 415, 427 (1792); *Persoon*, Syst. Veg. ed. XV: 703 (1797); *Ventenat*, Tabl. Reg. Veg. III: 386 (1799); *Andr.* Bot. Rep.: t. 568 (1799-1811); *Willdenow*, Spec. Plant. ed. IV, III, 2: 114 (1800); *Moench.*, Méth. Plant. suppl.: 52 (1802); *St. Hil.* Exp. Fam., II: 213 (1805); *Persoon*, Syn. Plant. II: 309 (1807); *Sims* in Curt. Bot. Mag. XXXI: t. 1241 (1810); *Ait.* Hort. Kew. IV: 317 (1812); *Sprengel*, Anleit. ed. II, II, 2: 754 (1818); *H. G. Bronn*, De Form. Pl. Leg.: 132 (1822); *Thunberg*, Flora Cap. II: 565 (1823); *De Cand.*, Prodr. II: 121 (1825); *La marck & Mirbel*, Hist. Nat. Veg. III: 266 (1826); *Reich.* Conspr. Reg. Veg.: 153 (1828); *Sprengel*, Gen. Plant. ed. Nona, I: 590 (1830); *Bartling*, Ord. Nat. Plant.: 409 (1830); *G. Don*, Gen. Hist. II: 131 (1832); *E. Spach*, Hist. Nat. Veg. Phan. I: 191 (1834); *Meisn.*, Plant. Vasc. Gen.: 60 and 85 (included in a key) (1837); *Endlicher*, Gen. Plant.: 1261 (1840); *Reich.*, Nomenclator: 151 (1841); *Endlicher*, Ench. Bot.: 667 (1841); *Brongn.*, En. Gen. Plant.: 127 (1843); *Benth.* in Lond. Journ. Bot. II: 442 (1843); *Hook.* in Curt. Bot. Mag.: t. 4034 (1843); *Lindley*, The Veg. Kingd.: 553 (1846); *Harvey & Sonder*, Flora Cap. II: 14 (1861-62); *Benth. & Hook.* Gen. Plant. I: 472 (1862); *Taubert* in Engl. & Prantl, Nat. Pfl. Fam., III-3: 215 (1894); *Adamson & Salter*, Flora Cape Pen.: 460 (1950); *Phillips*, Gen. S.A. Fl. Pl., ed. 2: 401 (1951); *Hutchinson*, Gen. Fl. Pl. I: 347 (1964).

## DESCRIPTION

*Shrubs* of varying habit, low and more or less prostrate, or erect and up to 2.50 m tall. *Branches* weak or stout, smooth though usually with numerous prominent cicatrices of fallen leaves and with more or less decurrent ridges; yellow-brown in colour but turning silvery grey with age, glabrous to hairy, often with a tuft of more or less persistent hairs in the axils of the leaves. *Stipules* if present, extremely small. *Leaves* simple, sessile, straight, slightly spreading and pointing upwards or deflexed, rigidly coriaceous, usually with a pungent mucron, acuminate, ovate to obovate or elliptic, or oblong, commonly glabrous, sometimes hairy. Various sizes (dwarfed leaves occur regularly, often directly below the inflorescence), glaucous to dark green, often slightly waxy or pruinulose, the main veins (3-7) and the often more or less cartilaginous edges yellow, the mucron often brown. *Inflorescence* terminal, solitary, paired or few clustered

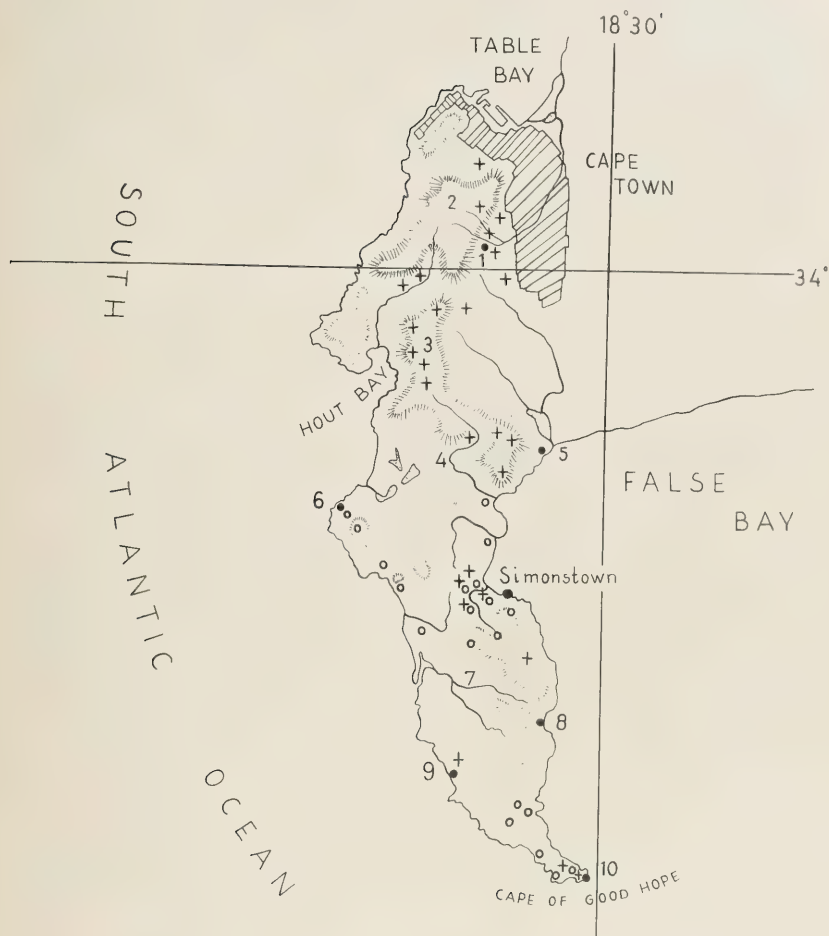


FIG. 1.

Distribution of *Liparia*. 1. Kirstenbosch; 2. Table Mountain; 3. Constantiaberg; 4. Silvermine River; 5. Muizenberg; 6. Kommetjie; 7. Klaasjagers River; 8. Smitswinkel Bay; 9. Bright-water; 10. Cape Point. + *Liparia splendens* subsp. *splendens*; o *Liparia parva*.



together on short lateral branches at the end of the branch, or  $\pm$  sessile; usually nodding, occasionally erect, consisting of many flowers in a contracted, bracteate raceme, with the appearance of an involucreted head. Each bract, except those on the outside of the inflorescence, subtending a flower. *Peduncle and pedicels*, short and hairy, the former with the last few mm entirely barren. *Bracts* large and conspicuous, the outer suborbiculate or broadly ovate-acuminate, the inner ones usually narrower and slightly longer than the outer; tips rounded or tapering to apiculate. The bracts appear petaloid, pale green to pale yellow at first, often partly turning reddish, sometimes dark maroon; surface usually glabrous, but sometimes variously hairy; edges glabrous to densely ciliate. *Calyx* 5-lobed, with a short tube, the base becomes strongly intruse in anthesis. Uppermost lobes cleft, narrowly triangular, the laterals often deeper cleft, the anterior lobe very different, much larger and usually more than twice as long as the other lobes and much wider, obovate and boatshaped, entire or more or less dentate at the tip. Lobes glabrous or variously hairy, the anterior lobe usually less hairy than the others. Calyx usually pale yellow, the largest lobe resembling the bracts. *Corolla* papilionaceous, the petals almost equal in length, and about equalling or much exceeding the anterior calyx lobe, glabrous, pale to orange yellow, sometimes with some red colouring. *Vexillum*  $\pm$  ovate, with two successive perpendicular bends in the narrow basal part. Above the second of these straightening, more or less plicate along the midrib, and with the lateral margins strongly reflexed-inrolled on the back, either with the central field remaining partly expanded or entirely inrolled and leaving hardly any expanded central part; sometimes the lateral margins lobed in the upper part. *Alae* clawed (claw spirally twisted), limb oblong  $\pm$  rectangular to obliquely cuneate; usually tightly wrapped round the carina, and often surrounding each other, enveloping the carina in various ways by their more or less lobular lower margins. *Carina* usually hidden within alae and lower calyx-lobe, narrow, straight to falcate, curved near the middle, consisting of two petals, which are free, and somewhat twisted at their narrow base and usually lower margins connate in the upper half; upper margins free and closely adnate, or partly connate but always free at base and in a few apical mm. All 5 petals inserted on a slightly raised base, which is adnate to both the receptacle and the staminal sheath, and may produce nectar. Stamens and pistil enclosed within the carina. *Stamens* 10, glabrous, diadelphous, the vexillar stamen free, the other 9 connate in a dorsally open tube. Tube short, soon disintegrating by gradually splitting off the marginal filaments till the last 3; ventral stamens free at about half their length. Usually filaments and anthers dimorphous, i.e. alternately longer filaments carrying shorter anthers (including the vexillar stamen), and slightly shorter filaments carrying slightly longer anthers. Anthers versatile. *Ovary*

almost sessile, densely appressed hairy outside and gradually narrowing to a more or less curved style, which becomes glabrous at about the same height where the staminal sheath ends, gradually tapering to the minute, hairy, obliquely capitate stigma; ovules up to 8, pendulous, of which usually only a few develop into seeds. *Pods* flat, oblique, continuous, hairy, style remnant usually persisting, opening by two valves, twisting. *Seeds* bean-shaped with a brown leathery skin, albuminous, on a stout funicle, the hilum surrounded by a collar-like stropholus.

TYPE SPECIES. *Liparia sphaerica* L. (= *L. splendens* (Burm. f.) J. J. Bos et de Wit).

#### DISTRIBUTION AND ECOLOGY

SOUTH AFRICA: S.W. Cape Province, west of Mosselbaai and south of Paarl; endemic. (Fig. 1, 2).

ECOLOGY. *Liparia* L. belongs in the "Cape fynbosch", usually growing in rocky or stony localities, on mountain slopes and flats, from sea-level to 1,200 m alt.; in small groups of few to fairly many individuals, often sprouting from subterranean radiating stems. The shrubs occur in rather restricted areas, apparently not much propagating by means of seedlings, since these appear to be very rare and were never noticed by me in the field; neither did I find any young plants on the localities I visited.

Although *Liparia* was cultivated in several conservatories in the last centuries (especially in England) and the older garden manuals describe it as fairly easy to raise from seeds and cuttings, it certainly is rare in living plant collections nowadays, even in its country of origin, and seeds do not readily germinate without special treatment. However, if the testa is slightly damaged, by scraping or filing, some seeds will germinate readily, while I found that untreated seeds did not germinate at all. Of further treatment we have as yet no experience but it should be noted that the older literature warns against direct watering on the foliage, which "is certain to kill" the plants after some time (*G. Don*, Gen. Hist. II, p. 133. 1832).

#### KEY TO THE SPECIES AND SUBSPECIES

1. Shrubs, usually erect, occasionally more or less prostrate, up to 2.50 m high. Lateral calyx-lobes usually equalling or slightly exceeding the upper pair. Corolla bright- to orange-yellow, usually with red markings on the alae. Vexillum 2—4 cm long, expanded part between the revolute margins at least 8 mm wide . . . . . *L. splendens*
  - Edges of the flower-bearing bracts and lower calyx-lobes glabrous, or partly ciliate, but at least more than half of their total circumference glabrous . . . . . subsp. *splendens*
  - Edges of the flower-bearing bracts and lower calyx-lobes ciliate, or partly so, but at least more than half of their total circumference hairy . . . . . subsp. *comantha*

2. Subshrubs, more or less prostrate, up to 30 cm high. Lateral calyx-lobes usually shorter than the upper pair. Corolla greenish to pale yellow, lacking red markings. Vexillum up to 2 cm long, up to 4 mm across, its margins strongly revolute .. .. . *L. parva*

***Liparia splendens* (Burm. f.) J. J. Bos et de Wit, comb. nov.**

TYPE. Holotype not traceable; neotype Bos 1 (WAG)  $\pm$  duplicates. Homotypic synonym: *Leucadendron splendens* Burm. f. (N. L. Burmann) Prodr. Fl. Cap.: 4 (1768); DC. Mém. Leg.: 191–192 (1825) (*in synonym.*); Thistleton-Dyer, Fl. Cap., vol. V-1: 552 (1911) (imperf. known spec.); DC. Prodr. II: 121 (1825) (*in synonym.*).

Heterotypic synonyms. *Liparia sphaerica* L., Mant. II: 268 (1771); Murray, Syst. Veg. ed. XIII: 554 (1774); id., Syst. Veg. ed. XIV: 665 (1784); Persoon, Syst. Veg. ed. XV: 703 (1797); Sprengel, Syst. Veg. ed. XVI: 271 (1826); Reichard, Syst. Plant. ed. Nov. III: 479 (1780); Houttuyn, Syst. Plant. IV: 238 (1779); Gmelin, Syst. Nat. ed. XIII. II: 1113 (1791); Willdenow, Spec. Plant. ed. IV. 1800, III-2: 1114 (1800); Thunberg, Prodr. Pl. Cap.: 123–124 (1794–1800); Andr., Bot. Rep.: t. 568  $\pm$  Fig. (1799–1811); Persoon, Ench. Syn. Plant.: 309 (1807); St. Hil., Exp. Fam. II: 213 (1805); Sims in Curtis's Bot. Mag. 31: t. 1241  $\pm$  Fig. (1810); Bronn, Form. Plant. Leg.: 60 (1811); Link, Enum. alt. II: 240 (1822); Thunberg Fl. Cap. II: 565 (1823); Lodd., Bot. Cab. 7, t. 642  $\pm$  Fig. (1818–1824); DC. l.c.; G. Don, Gen. Hist. 1832, II: 131 (1832); E. Spach, Hist. Nat. Veg. Phan. I: 191 (1834); Ecklon & Zeyher, En.: 164 n. 1215 (1836); E. Meyer, Comment. Dr.: 17 (1835); Walp. in Linnaea XIII: 468 (1839); Walp. Rep. I: 580 (1842); Meisn. in Lond. Journ. Bot. II: 63 (1843); Benth. in Lond. Journ. Bot. II: 443 (1843); Harvey & Sonder, Fl. Cap. II: 14 (1861–62); Taubert in Engl. & Prantl. Nat. Pfl. Fam. III-3: 215 (1894); Adams & Salter, Fl. Cap. Pen.: 640 (1950). Homotypic synonyms *Borbonia sphaerica* (L) Lmk, Enc. Méth. Bot. 1 (2): 437 (1738).

**Subsp. *splendens***

*Shrubs* between 30 cm to 2.50 m high; stems stout, usually glabrous, but sparse long, weak, simple hairs may occur, especially directly below the inflorescence. Tufts of white to rusty coloured hairs may persist for some time in the leaf-axils. Stipules rarely quite absent, sometimes up to  $\frac{1}{2}$  cm long. *Leaves* very variable, between ( $2\frac{1}{2}$ —)  $3\frac{1}{2}$ — $5\frac{1}{2}$  (— $6\frac{1}{2}$ ) cm long and —17 (5—27) mm wide; mucronate tip pungent and almost spiny, or sometimes callous and blunt; directed upwards to densely imbricate at the ends of the branches, entirely glabrous (except the leaf directly below the inflorescence which may be more or less ciliate on the edges). Foliage leaves mostly become dwarfed (7 mm long, 3 mm wide and less), as transitions to the bracts, and these often show a rather dense ciliation on the edges. They (and some larger leaves directly below them)

*The Genus Liparia L. (Pap.)*



FIG. 2.

Distribution of *Liparia splendens*. 1. Bellville; 2. Paarl; 3. Betty's Bay; 4. Hermanus; 5. Stanford; 6. Paviesslei; 7. Elim; 8. Danger Point; 9. Napier; 10. River Zonder End; 11. Robertson; 12. Albertinia. + *Liparia splendens* subsp. *splendens*; ⊕ *Liparia splendens*, subsp. *comantha*.

may bear some hairs on the upper surface, spreading from profuse axillary tufts. *Inflorescence* mostly solitary, terminal, nodding, (3½—) 4—7 (—8) cm long and (4—) 5—8½ (—10) cm wide. Pedicels about 4 mm long. *Bracts* usually shorter than the leaves (2—) 2½—3½ (—4½) cm long and (3—) 5—20 (—23) mm wide, the inner bracts usually narrower, the outer usually 15 mm wide. Lowermost bracts often comparatively small, resembling the uppermost leaves in being slightly hairy on the upper surface due to profuse axillary hair, and densely ciliate on the edges. The lower surface is always glabrous. The main body of bracts is entirely glabrous, but the edges may be slightly ciliate near the base in the better part of the bracts, while intermediary forms may show interrupted or lax fringes on all bracts. The margins are entire, very rarely laterally irregularly lobed or with a three-dentate tip. In the inner lobes sometimes long drawn out tips may occur. *Calyx* (1½—) 2½—3½ cm long or slightly longer, the tube (3½—) 4—6 (—7) mm long, (4—) 5—6 (—8) mm wide, glabrous or slightly hairy outside (if hairy then usually in strands below the incisions between the lobes). Upper lobes small, narrow, apiculate or mucronate (5—) 8—11 (—15) mm long and (2—) —3— (—5) mm wide at base, connate in the lower part up to ½ their length, glabrous (or occasionally sparsely hairy), margins below usually barbato-ciliate by short woolly hairs, the free part of the upper margins ciliate,



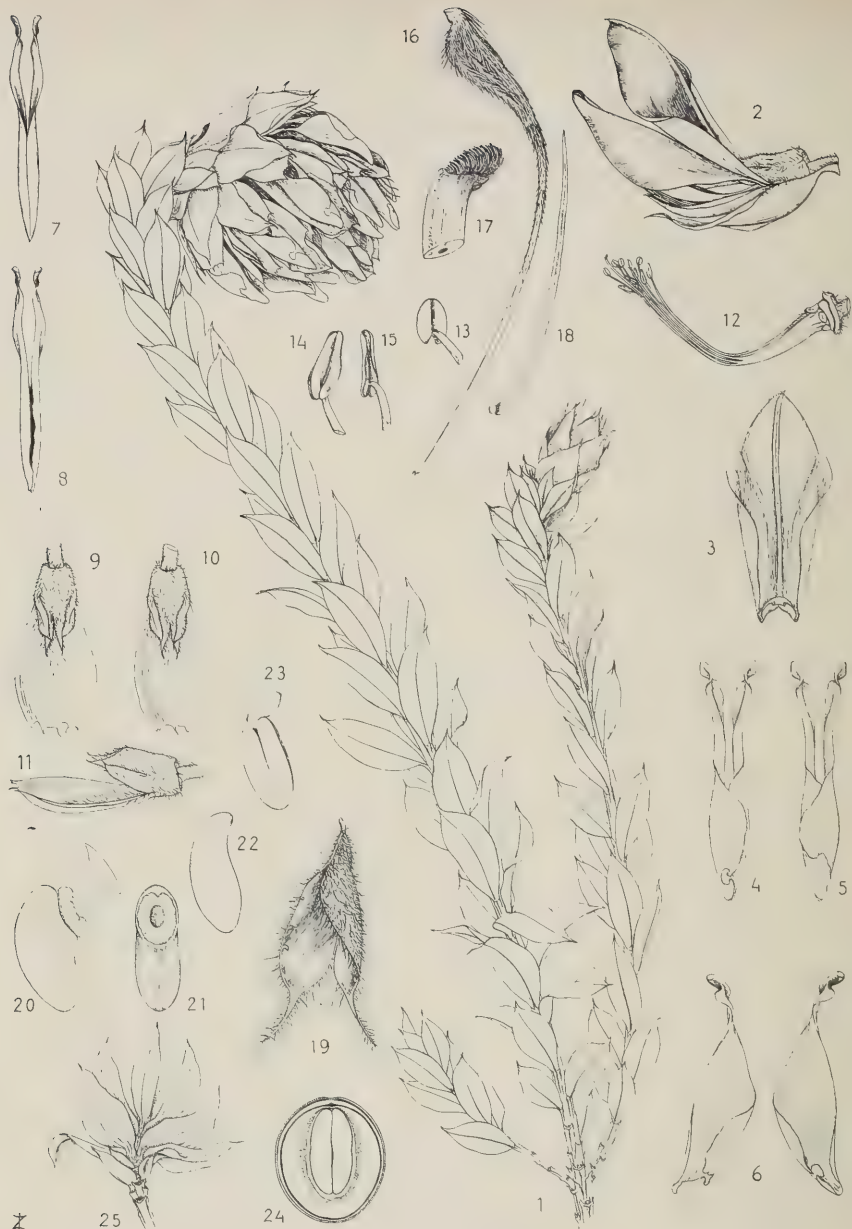


FIG. 3.

*Liparia splendens* subsp. *splendens* 1. flowering branch ( $\times \frac{1}{2}$ ); 2. flower and bract; 3. vexillum (adaxial); 4, 5. alae (from below); 6. alae (opened, inner surface); 7. carina (from below); 8. carina (above); 9, 10. calyx (upper view); 11. calyx (laterally); 12. staminal tube (calyx partly removed); 13. small anther, still closed ( $\times 5$ ); 14. large anther, laterally, open ( $\times 5$ ); 15. large anther, posteriorly, open ( $\times 5$ ); 16. pistil ( $\times 2$ ); 17. stigma ( $\times 20$ ); 18. hair of ovary ( $\times 40$ ); 19. pod; 20. seed laterally ( $\times 3$ ); 21. seed ventrally ( $\times 3$ ); 22. endosperm, testa removed ( $\times 3$ ); 23. embryo ( $\times 3$ ); 24. transverse section of seed ( $\times 9$ ); 25. top of branch with bracts, flowers removed ( $\times \frac{1}{2}$ ). 1-18, 25: Bos 1, neotype (WAG); 19: Bos, Oranje Kloof (WAG); 20-24: Rycroft 446, Oranje Kloof (WAG), seeds only.



or glabrous though apparently ciliate because of the densely villous inner surface. Always glabrous in the connate part inside and sometimes glabrescent towards the tip. Lateral lobes usually subfalcate, about equalling the upper lobes, similarly hairy, though less often ciliate on the upper edges, and on the inner surface from the base upwards villous but often glabrescent or glabrous apically. Lower lobe usually (4—) 3 dentate, the tip blunt, and occasionally apiculate (the midrib terminated by a short mucron) (15—) 20—30 (—33) mm long and (6—) 9—15 (—18) mm wide, usually glabrous outside though some lax hairs may occur in the lower third; on the inner surface a triangular villous patch at the base of the lobe, up to  $\frac{1}{2}$  or  $\frac{3}{4}$  of its length, rarely longer but then the patch puberulous and only villous along its margin, edges usually glabrous, occasionally the margins in the lower part may be more or less hairy. Intermediary specimens may show some lobes with sparsely ciliate edges. *Corolla* from about equal to twice as long as the larger calyx-lobe, of a bright warm to orange-yellow colour often with some red on the wings, vexillum and tip of the carina. *Vexillum* partly expanded and slightly plicate along the midrib above the two sharp bends near its base; margins laterally strongly revolute in anthesis and inrolled at the back (in young flowers the vexillum may be entirely expanded); margins entire or the revolute part crowned by a shallow lobe (rarely bilobular), usually about 1 cm from the tip. The top part of the vexillum above these lobes (or revolute parts) slightly incurved to shallowly cucullate (the apiculate tip of the midrib pointing forwards), 4—3 cm long, 15—23 mm wide, while the expanded part, between the revolute margins is (8—) 10—15 mm wide. In flower the vexillum usually stands well apart from the other petals, but in bud it encloses the others entirely. *Alae* equalling the vexillum or almost so, claw  $\pm$  7 mm long, 3 mm wide, twice twisted in opposite directions, then the limb gradually widening and becoming obliquely wedge-shaped (upper margin straight), 8—11 mm wide at  $\frac{2}{3}$  to  $\frac{3}{4}$  of its total length; from this point the lower margin reaches the upper by forming two distinct lobes (often with a tiny third and rarely a 4th lobule between them). The margins lock round the carina by means of these lobes, either by alternately folding one lobe over the other or with the small lobules twisting around each other, thus somewhat resembling a bowtie (see Fig. 3 (4—6)). Petals of the *carina* more or less twisted like the alae in the narrow free base, equalling the alae in length, with a shallow upward bend at about  $\frac{1}{3}$  of its length, the upper half being straight, widest about the middle (3—5 mm), upper margins free or partly connate from here till about  $\frac{3}{4}$  of the length, the narrow tip of the carina rounded, sometimes slightly reddish, otherwise paler yellow than the other petals or similar. *Stamens* of the longer kind about 35—40 mm long, anther about 1 mm long; the stamens with shorter filaments carry  $1\frac{1}{2}$ —2 mm long anthers; connate part 15—17 mm

long. *Pistil* slightly longer than the stamens. *Ovary* short stalked ( $\pm 1$  mm), 7—8 mm long, densely appressedly hairy (hairs simple, bulbous-based, up to 3 mm long), style slightly stouter than the filaments, becoming glabrous at or slightly above the end of the staminal sheath, stigma fringed by minute, curved, papillate hairs. *Pod* 2—3½ cm long (mucron (style remnant) 3—5 mm),  $\pm 1$  cm wide. Of 6—8 ovules, 0—5 develop. Seeds 5—6 mm long, 2—4 mm wide, pendulous from a stout 1—2 mm long laterally compressed funicle, having an ariloid or strophiolate collar round its top, which becomes fully detached from both the funicle and the hilum, and leaves the micropyle exposed. Germ and cotyledons entirely surrounded by endosperm, which is differentiated into three distinct layers, the outermost white, the central cloudy-hyaline, and the inner touching the radicle and the cotyledons, translucent. The cotyledons show a shallow median furrow on the outside, the straight radicle points obliquely upwards, its tip close to the micropyle. Cotyledons of the seedling entirely glabrous.

**DISTRIBUTION:** At all altitudes below 1,000 m on the Cape Peninsula and Cape Flats, generally south of the Paarl and west of the Hottentots Holland mountains. One locality in the Mossel Bay district (Vreyersberg), forming the easternmost limit of the genus. (Fig. 1, 2.)

**ECOLOGY.** The shrubs mostly grow on rocky mountain slopes, sometimes near a small stream or in somewhat moist places, but also on “klipkoppies”, usually rooting in heavily rock-infested soil of granitic or Table-Mountain sandstone origin.

The plants seem to be able to produce flowers in every month of the year, judging from the collecting dates. May to November is the best period for flowering. On the southern peninsula no flowers were collected in July and August. Repeatedly seed collections were sown in the conservatory at Wagenin-gen without any indication of germinating. Numerous seeds were found to swell readily, but very few actually did germinate. In spite of all care and efforts no seedlings established themselves, growth was discontinued and the plantlets withered after producing healthy looking cotyledons on a short hypocotyledonous stem.

**TYPIFICATION.** The only specimen of *Leucadendron splendens* Burm. f. preserved in the Burmann Herbarium was remounted at an unknown date and is of unknown origin. It may have been added to the Burmann Herbarium after completion of the Prod. Fl. Cap. Moreover, the specimen is badly damaged and the inflorescence has disappeared. Specimens from the Burmann Herbarium are known to be preserved at LINN and at M. Among those no trace of *Leucadendron splendens* (or *Liparia sphaerica*) was found. A neotype is now designated, since any material that the author might have studied cannot be traced. As regards the typification of *Liparia sphaerica* L., a similar uncertainty exists.

Of the two sheets in the Linnean Herbarium, labelled as *L. sphaerica* by Linnaeus the younger, one was collected by Sparmann (no. 133), and thus cannot have reached Linnaeus before 1772, i.e. after the publication of *Mantissa altera* (1771). The other specimen is of unknown origin, and since it lacks any handwriting of Linnaeus cannot be accepted as the holotype. The practice of Linnaeus of giving away (type—) specimens when he received a "better" specimen of the same species or for other reasons, is well known.

POLLINATION. Scott Elliot (in *Ann. Bot.* 5: 543 (1890-91)) reported that cross-fertilisation by large insects standing on the vexillum of the flower while harvesting honey will be more effective than when the insect alights on the wings; he has not seen the insects actually pollinating, but suspects carpenter bees (*Xylocopa*). Marloth (*Fl. S. Afr.* 2: 72 etc. (1925)) mentions that he has observed sunbirds (*Anthobaphes violacea*) and carpenter bees (*Xylocopa capensis*) visiting the flowers for their honey. Vogel summarises these findings (*Bot. Stud.* Heft 1: 211 (1954)), gives an extensive description of the flower, and deduces that pollination will take place according to the pumping principle, whereby the honey-sucking bird by pressing its head or bill into the flower between the vexillum on one side and the other petals on the other side, presses or pumps the pollen on top of the style out of the tip of the carina. The pollen and stigma so come into contact with the throat feathers of the bird and cross pollination may follow.

## SPECIMENS EXAMINED

(Specimens marked \* were sent to me on loan)

CAPE PROVINCE. Hills near Cape Point, *Schmidt* 349 (M\*). Brightwater, *Leighton* 1617 (BOL). Millers Point, *Marloth* s.n. (PRE). Simonsbay, *Alexander* 23 (K\*), *Dümmer* 79D (E\*), ?*Wright* 550 (TCD\*, K\*). Red Hill, *Jameson* s.n. (K\*), *Rogers* s.n. (PRE), *Bos* 330 (WAG\*). S. Penins: ?*Hesters dam*, *Galpin* 12776 (PRE), *Salter* 2087 (BM\*). Silvermyn, *Werdemann & Oberdieck* 76 (B\*). *Anon.* 35 (S\*). Kalk Bay-Muizenberg, *Andreae* 122 (PRE), *Barker* 4206 (NBG\*), *Barnard* s.n. (SAM\*), *H. Bolus* 2975 (NY\*, BOL, PRE), *Harvey* s.n. (BM\*), *Hickson* s.n. (SAM\*), *Marloth* 6363 (PRE), *Meebold* 13315 (M\*), *Moss* 4262 (BM\*), *Alexander Prior* s.n. (K\*, PRE), *Thode* s.n. (STE), *Wall* 564/54 182 (LD\*), *Anon.* s.n. (TCD\*). Steenberg, *Dümmer* 1154 (E\*), *Ecklon* s.n. (P\*). *Pillans* s.n. (PRE). Constantiaberg, *Compton* 12542 (NBG\*), 20233 (NBG\*), ?*McOwan* s.n. (E\*), *Wolley Dod* 2153 (K\*, BOL). Houtbaai: Skoorsteenkop, *Acocks* 689 (PRE), 2319 (S\*). Tierbos, *Acocks* s.n. (S\*). Constantia, *Krauss* s.n. (M\*, WRSL\*), *Pappe* s.n. (K\*), *Pillans* 10657 (MP\*, NY\*), *Salter* 9462 (BM\*), *Wallich* 129 (TCD\*, BM\*, PRE). Oranje Kloof, *Schelpke* 3896 (BM\*), *Bos* 681 (WAG\*). Cape Flats between Cape Town and Simons Bay, *Burchell*

8585 (S\*, P\*, GOET\*, PRE, K\*, L\*, NY\*, M\*). Wynberg, Drège ?473 (P\*, BM\*). Table Mt. *H. Bolus* 2975 (BM\*), *J. Bolus* 1621 (PRE), *Ecklon & Zeyher* 1215 (SAM\*, M\*, S\*), *Kassers* 118 (HBG\*), *Krauss* 937 (NY\*), *McOwan* 1423 (SAM\*, UPS\*, STE), 2313 (SAM\*), *Marloth* 7 (PRE), *E. Meyer* s.n. (S\*), *Rehmann* 848 (BM\*), *Werdemann & Oberdieck* 76 (PRE), *Anon.* s.n. (NBG\*), ib. pone Constantiam, *Anon.* 54 (TCD\*). Kirstenbosch (above Window creek), *Barker* 326 (NBG\*), *Esterhuyzen* 221 (NBG\*), 17334 (BOL, PRE), *Bos* 680 (WAG\*), ib. Mnts. above, *Hutchinson* 54 (K\*), ib. Trolley track, *Compton* 10320 (NBG\*). Cape Town, *Harvey* ?550 (TCD\*), *Hesse* s.n. (GOET\*). Cape Peninsula, *Phillips* s.n. (SAM\*), *Thunberg* s.n. (S\*), Herb. Vocke ?6463 (GOET\*, "*Leucadendron splendens*"), *Wood* 1605 (ex herb. Ch. d'Alleizette, L\*). Brackenfell, *Bos* 411, 412 (WAG\*), *Bos* 1 (neotype, WAG\* + dupl.). Kuilsrivier, *Bosman* s.n. (BOL). Bot-lercy, *Bosman* ?557 (STE). Vlotenburg, *Duthie* 557a (STE\*, intermediary). Stellenbosch, *Duthie* 557 (BOL\*). Mossel Bay, *Muir* 2055 (BOL\*, PRE\*). Spec. ex Hort.: Kirstenbosch, *Henderson* 1044 (PRE), *Schmidt* 349 (M\*). Stellenbosch, *Krige* s.n. (intermediary, BOL\*). Hort. Tolos.: Herb. *Moquin-Tandon* s.n. (P\*). Hort. Cavanilles, Herb. *Buckley* s.n. (MO\*). Hort. ?Leiden: Herb. *Persoon* s.n. (L\*).

UNCERTAIN LOCALITY. Stellenbosch-Vlakkenberg, *Marloth* 7476 (PRE\*). Nursery ravine, *Marloth* 11985 (PRE). Constantia, bought at the door, *Arbuthnot* s.n. (STE). Wild Flower show Stellenbosch 1961, *Kirstenbosch* 658 (PRE, STE).

CAPE OF GOOD HOPE. *W. Brown* s.n. (E\*), Herb. *Al. de Bunge* s.n. (P\*), ?*De Candolle* s.n. (P\*), Drège ?473 (K\*, PRE, P\*), ?*Ecklon & Zeyher* ?1215 (FI\*), *Gueinzus* s.n. (S\*), *Harvey* 766 (E\*), 6463 (E\*), *Lehmann* s.n. (P\*), *Niven* s.n. (BM\*), *Cole* s.n. (ex. herb. *Mackay*, TCD\*), ?*Poeme* s.n. (L\*), *Preisiz* s.n. (UPS\*), Herb. *Retzius* s.n. (LD\*), *Reynaud* s.n. (ex. herb. *Jussieu*, P\*), *Roxburgh* s.n. (BM\*), *Sieber* 151 (BM\*), *Thunberg* s.n. (S\*), Herb. *Wendland* s.n. (GOET\*), *Anon.* s.n. (P\*), Herb. *Barnardi* s.n. (MO\*), Herb. *Henschel* 457 (WRSL\*), Herb. *Splitgerber* s.n. (L\*).

SOUTH AFRICA. *Ecklon & Zeyher* s.n. (LD\*), *Scott Elliot* s.n. (ex. herb. *Scully*, E\*).

NO LOCALITY. *Forbes* 261 (BM\*), s.n. (K\*), Herb. *Reinwardt* s.n. (L\*), *Dahl & Thunberg* s.n. (S\*), *D. Thunberg* s.n. (S\*), *Anon.* s.n. (S\*), Herb. *Henschel* s.n. (WRSL\*), *Anon.* s.n. (LINN), *Sparmann* 133 (LINN), *de Monchy* s.n. (G-DC), *Lambert* s.n. (G-DC), *Thunberg* herbarium (UPS, 2 sheets). Subsp. *comantha* (Eckl. & Zeyh.) J. J. Bos et De Wit, comb. et stat. nov.

TYPE. *Ecklon et Zeyher* 1216, "Hottentotshollandskloof" prope "Palmiet-rivier" (Stellenbosch), lectotype, P; ?isotypes at M, LD (2 sheets), K.

Homotypic synonyms. *Liparia comantha* Eckl. & Zeyh., En.: 164, n. 1216



(1836); Walpers in *Linnaea* XIII: 468 (1839); Walp. Rep. I: 580 (1842); Benth. in *Lond. Journ. Bot.* II: 443 (1843); Harvey & Sonder *Fl. Cap.* II: 15 (1861–62).

**HETEROTYPIC SYNONYMS.** *Liparia burchellii* Benth. in *Lond. Journ. Bot.* II: 443 (1843). Harvey & Sonder *Fl. Cap.* II: 15 (1861–62).

**TYPE.** Burchell 6881 K (holotype), GOET, L, M, P, (isotypes). *Liparia parva* Vog. ex. Walp. var. *angustifolia* Benth. ex. Hook. in *Curtis's Bot. Mag.*: t. 4034 + Fig. (1843). Type. ?Benth. s.n. Culta K (holotype).

*Shrub* usually 30–90 cm high, occasionally not erect but more or less prostrate and decumbent (north of Sir Lowry's Pass, Hott. Holland mnts.). *Branches* glabrous to sparsely pilose, young parts often hairy, soon glabrescent, few hairs persistent below the inflorescence. Stipules usually present, rarely up to 3 mm. *Leaves* variable, 2–5 cm long, 5–15 (–20) mm wide. Dwarfed leaves less than  $\frac{1}{2}$  cm long occur rather frequently. Mucronate tip straight, sometimes hooked, usually glabrous, some solitary hairs may be present, edges occasionally minutely scabridly toothed, sometimes fringed with long weak hairs, especially when young, and often directly below the inflorescence. *Inflorescence* terminal, single or few clustered together on short lateral branches or almost sessile, usually nodding, but occasionally more or less erect ( $2\frac{1}{2}$ –) 3–6 cm long and (3–) 4–7 cm wide. Pedicels 2–4 mm long. *Bracts* usually shorter than the leaves but as wide: (9–) 15–30 (–35) mm long and (3–) 5–16 (–20) mm wide. They are glabrous on the faces, but the edges are usually ciliate with a short fringe of white or rusty coloured hairs, usually rather dense, but sometimes more laxly so, or glabrescent to glabrous edges on few bracts or partly thus; in few specimens with glabrous tips or glabrescent edges in the upper half and in one case only so in the lower half. Intermediary specimens show rather lax fringes, with extensive glabrous or glabrescent parts of the edges, but they are considered to belong to this subspecies when more than half of the edges of both bracts and larger calyx lobes are ciliate, however laxly that may be. *Calyx* 1.5–3 (–3.5) cm long, the tube 3–5 mm long and 4–6 mm wide, densely hairy outside, occasionally less hairy and subglabrous in the intermediary. The upper lobes usually connate till about  $\frac{1}{3}$  or  $\frac{1}{2}$  their length, (4–) 5–10 (–12) mm long, 2–4 mm wide, the lateral about similar though often slightly falcate and a little longer, rarely shorter than the upper pair (4–) 5–10 (–15) mm long and 2–3 mm wide, sparsely to densely hairy outside and densely ciliate on the margins, sometimes with stout hairs to the upper and woolly-barbate to the lower edges. The large lower lobe may be simply apiculate or more or less distinctly 2–3 dentate at the tip (even within the same inflorescence). It is (10–) 15–21 (–30) mm long and (3–) 5–10 (–15) mm wide, at or about the middle, 3 mm wide at the very base. Hairy outside but often only



sparsely so, the hairs thinning from the base upwards and becoming glabrescent to glabrous in the upper  $\frac{2}{3}$  to  $\frac{1}{2}$ . The edges usually densely ciliate, but the fringes may dwindle in the upper part, while the intermediary forms only show dense fringes at the very base of the edges, these soon becoming glabrescent with only occasional hairs on the edges of the upper parts. The inside villous but often with a puberulous patch in a triangle from the base to the centre surrounded by the longer hairs, more rarely with a glabrous tip and glabrous margins inside. *Corolla* overtopping the larger calyx lobe slightly to up to 2 cm, usually however, about 1 cm longer. *Vexillum* (20—) 25—40 (—45) mm long, entire width between 13 and 23 mm, the expanded part between the revolute lateral margins, 8—10 mm wide at its widest part. *Alae*-claw about 4—6 mm long, the widest part of the limb 6—14 mm wide, the total length about equal to the vexillum. The top end of the lower margins rarely not clearly lobular. *Carina* about equal to alae and vexillum in length, 3—6 mm wide in the widest part. *Stamens* with anthers occasionally not clearly of two kinds. The first leaves of the seedling glabrous, but the next may have some long weak hairs. Other characters as in subsp. *splendens*.

#### DISTRIBUTION

Somerset-West (east of Hottentots Holland mountains), Caledon, Bredasdorp, Swellendam and Riversdale. The Aasvoelberg south of Albertinia is the easternmost locality, Genadendal and Langeberg the northern limit. Always on rocky grounds, often on mountain slopes, never in large quantities. Altitudes from sea-level to 1,200 m, usually about 500 m. (Fig. 2.).

**FLOWERING PERIOD.** Flowering specimens have been collected in every month of the year, excepting February; most frequently however, in the months of July through to October, far less often in June and November, and only occasionally in the other months.

**ECOLOGICAL NOTE.** Usually a sprouting shrub, often vigorously growing in more or less regularly burned areas (e.g. open firebelts in Forestry Reserves). Due to topping, the plants remain low in those localities, not over 1 m high, but will expand by sprouting from underground parts. On windy exposed places on top of the Hottentots Holland mountains the plants attain a more or less prostrate habit, as though seeking protection from the other vegetation and rocky outcroppings. Plants growing with other *fynbos* remnants surrounded by planted *Pinus*-forests (at Libanon and Houhoek) may attain rather large proportions, but remain open and sparingly branched. Here as well as on the exposed lower slopes close to the sea (at Betty's Bay) the foliage was observed to be more hairy than in other localities.

Seeds sown at Wageningen in the conservatory did not germinate if not specially treated; when the testa was scratched or shallowly cut into, about half

of them did germinate readily, and seedlings, if protected from snails, developed.

BIOLOGICAL NOTES. No special observation of the pollination of this subspecies is extant, but as the flowers of both subspecies are similar in structure and differ but slightly in size, most probably they are pollinated in the same way as was observed in the other subspecies, sunbirds being the agents.

Upon examining freshly picked specimens from the Sir Lowry's Pass area (Bos 1393), I noticed a sluglike insect exactly resembling the leaves of this plant. The insect so closely resembled a leaf, that some students, who were asked to indicate the animals seated on a branch held before them at a distance of less than 1 m, failed to do so; I myself only saw it when I examined the branch and was puzzled by the irregular insertion of a "leaf", which suddenly moved when being touched.

The Entomological Department at Stellenbosch University identified this as a caterpillar of unusual habit. With some difficulty a second specimen was secured from the same area, and both were cultivated by Dr. Theron. Due to easier accessibility of fresh material of *L. splendens* subsp. *splendens*, their nourishment was switched to these leaves after the initial stock of subsp. *comantha* leaves had run out. They did not show any difference in habit or behaviour after this change of diet, and proceeded to turn into the pupal stage after 2 months (the end of June). Upon hatching, the imago proved to be a moth, and at the Transvaal Museum at Pretoria, Dr. Janse identified it as *Homosusica eugrapha* Janse (*Limacodidae*), a very recently published new monotypic moth-genus (Janse, The Moths of S. Afr. VII: 90-91 (1964)).

#### SPECIMENS EXAMINED

(Specimens marked † are fairly glabrescent on the edge of the bract)

CAPE PROVINCE. Sir Lowry's Pass, Bos 639 (WAG\*†), 1394 (WAG\*), Burchell 8229 (K\*), Parker 4578 (MO\*, BOL), Stokoe s.n. (SAM\*). Hottentots-holland near Palmietriver, Bos 1393 (WAG\*), Petzer s.n. (WAG\*), Ecklon & Zeyher 1216 (type material of *Liparia comantha* E. & Z., P\*, L\*, K\*, S\*, SAM\*), id. Drège label (LD\*, FI\*, NY\*, MO\*, L\*, PRE (3), M\*, GOET\*), Guthrie s.n. (BOL), Ecklon & Zeyher 56, 5 (Grietjesgat) (E\*, UPS\*, GOET\*, LD\*, BOL\*, L\*, TOD\*), Anon. s.n. (STE). Palmietriver, Guthrie 3865 (NBG\*, BOL). Kogelberg, Stokoe s.n. (SAM\*). Betty's Bay, Bos 375 (WAG\*), 670 (WAG\*). Highlands, Bos 380 (WAG\*), Stokoe s.n. (SAM\*), Linley s.n. (SAM\*). Houhoek Pass, Vogts 210 (WAG\*). Libanon For. Res., Bos 678 (WAG\*). Genadendal, Kogel ?3745 (B\*, intermediary). Zwarteberge (*supra thermas*). Gillet 1073 (BOL\*), Zeyher 2278 (FI\*, P\*, SAM\*). Caledon, le Roux s.n. (STE), Marloth 7090 (PRE\*), Esterhuyzen 2677 (Sugarloaf, BOL\*). Shaws Pass, Martin 1160 (NBG\*). Hermanus, Edgar s.n. (STE\*), Stokoe (herb. Marloth no. 9554) (PRE\*). Klein River mnts., Stokoe 6154 (BOL), Stokoe s.n.

(SAM\*). Danger point, *Leighton* 1584 (BOL). Between Stanford and Elim, *Middlemost* 2207 (NBG\*). Paviesvlei, *Geyer* 1160 (BOL\*). Elim, *Compton* 3451 (BOL\*), *Landsberg* s.n. (SAM\*). Bredasdorp: Fransche kraal, *Barker* 8495 (NBG\*). Hagelkraal, *Nigrini* s.n. (NBG\*). Napier, *Chait* (ex. herb. *Galpin*) 10478 (PRE\*). Swellendam, *van Rensburg* 12 (NBG\*), *Wurts* 214 (NBG\*), 296 (NBG\*, BOL\*), 390 (NBG\*). Riversdale: Langeberg near Corente river, *Muir* 795 (PRE), *van Breda* 1098 (PRE, K\*). Garcias pass, *Galpin* 3907 (PRE\*), ib. For. Res., *Bos* 700 (WAG\*). Albertinia, Aasvoëlberg, *Bos* 701 (WAG\*), *Burchell* 6881 (K\* (type of *Liparia burchellii* Bth.), P\*, M\*, GOET\*, L\*), *Muir* 632 (SAM\*, BOL\*, PRE), *Smallberger* s.n. (SAM\*).

UNKNOWN LOCALITY. ?*Ecklon & Zeyher* ?1215 (P\*), ?*Ecklon* s.n. (Nuwe-loof) (SAM\*), *Marloth* 7090b (PRE\*), Herb. *Vocke* (Afr. Austr.) ?6463 (GOET\*). Cape Town Flower Show 1921 (Hermanus exhibit) (BOL\*), ib. 1925 (BOL\*), ib. 1926 (Bredasdorp exhibit) (BOL).

CULTAS Kew, ?*Bentham* s.n. (K\*, type of *Liparia parva* var. *angustifolia*).

*Burchell* 8229 (K) has a budding flowerhead with all the bracts and upper leaves ciliate, and therefore belongs here. In herb. of the South African Museum at Kirstenbosch (SAM) I found one sheet with two collections by Stokoe (labelled with SAM-herb. nos. 55909 and 52205), both of an unusual character. SAM 55909 was collected by Stokoe in the Kleinriver mountains, east of Rocklands peak, and has remarkably wide leaves, by which it is distinguished. However, due to the rather wide variability of the leaves in *Liparia splendens*, and in the absence of any other collection, even from the same area, with similar wide leaves I prefer to refer this to subsp. *comantha*. SAM 52205, mounted on the same sheet with SAM no. 55909, consists of two fragments, one being an ovary and the other a juvenile pod still within the calyx. By their size and hairiness these fragments either belong in *L. parva* or *L. splendens* subsp. *comantha*. The absence of any data, and especially of the corolla, prevents a more certain identification of these fragments, but as the lateral calyx lobes are considerably shorter than the upper, they probably belong in *L. parva*, where this character is very common, whereas it is highly unusual in subsp. *comantha*.

The sheet in the Paris Herbarium bearing a printed label of "Ecklon & Zeyher 1215", being part of their Enumeratio, consists of a hairy (margins of the bracts fully ciliated) specimen of *L. splendens* var. *comantha* (or *L. comantha* Eckl. & Zeyher). Most likely the specimen is part of the extensive collection of duplicates of the type specimen of *L. comantha* Eckl. & Zeyh., no. 1216 of the Enumeratio.

A specimen at Kew, presumably of *Bentham*'s, which was beautifully pictured in the Botanical Magazine, t. 4034, forms the type of *Bentham*'s *L. parva* var. *angustifolia* which was placed in *Liparia parva*, mainly because of its small size

and decumbent habit. This specimen originated from a plant long cultivated in Kew Gardens, and might well have become different in habit from wild specimens. I have transferred it to subsp. *comantha* in *L. splendens*. The shape of the petals as well as their colour clearly supports this view and this also explains the narrow leaves. *L. splendens* shows widely variable, though mainly oblong leaf-shapes, whereas *L. parva* tends to smaller but ovate or suborbicular leaves. It seems unwarranted to maintain var. *angustifolia* as a distinct variety and so it is included in subsp. *comantha*.

The following specimens lack any flowering or fruiting parts and therefore remain in *L. splendens* without subspecific designation: Herb. Burmann (ex herb. Delessert, G\*), Jard. Boussault 1818 (G-DC), Conradie s.n. (WAG\*), Herb. Persoon s.n. (L\*), herb. van Royen s.n. (L\*), Wallich 766 (BM\*), Anon. s.n. (S\*). It is possible that the Burmann specimen is the holotype of *Liparia splendens* (see under typification of *L. splendens*), but it lacks the flower-head which was broken off at some time, and it shows a strong resemblance to the specimen in the van Royen herb. at Leyden, here cited, of which it could even be a duplicate. The van Royen specimen also lost its flower-head. The Conradie specimen possibly was collected from the same plant as my own no. 701. It certainly comes from the same small growing locality but lacks flowering parts, and thus should not be classified any further, although this particular spot has produced only subsp. *comantha*. The ciliation of the uppermost leaf of Conradie's specimen may seem to point towards subsp. *comantha*, but this occasionally is seen in subsp. *splendens* also.

*Liparia parva* Vog. ex. Walp. in *Linnaea* XIII: 468 (1839). Walp. *Repos.* I: 508 (1842). Benth. in *Lond. Journ. Bot.* II: 443 (1843). Hook. in *Curtis's Bot. Mag.* t. 4034 (not the Fig.) (1843). Harvey & Sonder, *Fl. Cap.* II: 15 (1861-62).

TYPE. Holotype ex. Herb. Kunth, probably destroyed in B; neotype, southwestern slopes of Klaasjagersberg, Cape Pen., *Sidey* 2142, S; (duplicates at WAG, PRE and MO).

Heterotypic synonym. *Liparia crassinervia* Meisn. in *Lond. Journ. Bot.* II: 63 (1843). Benth. in *Lond. Journ. Bot.* II: 443 (1843). Harvey & Sonder, *Fl. Cap.* II: 15 (1861-62) (as a synonym).

TYPE. *Krauss* s.n. "Uitershoeck" Sept. 1838 (holotype destroyed in B?), fragmo-klepto-isotype in NY (convolute pinned to sheet with *Krauss* specimen of *Liparia splendens* subsp. *splendens*, containing few leaves, the tip of a young branchlet, 1 flower and 1 bract).

*Shrublet*, low and more or less prostrate, not over 30 cm high. *Branches* weak and thin, occasionally stout and suberect, often densely hairy or villous, especially when young, they may become glabrous with age, occasionally quite



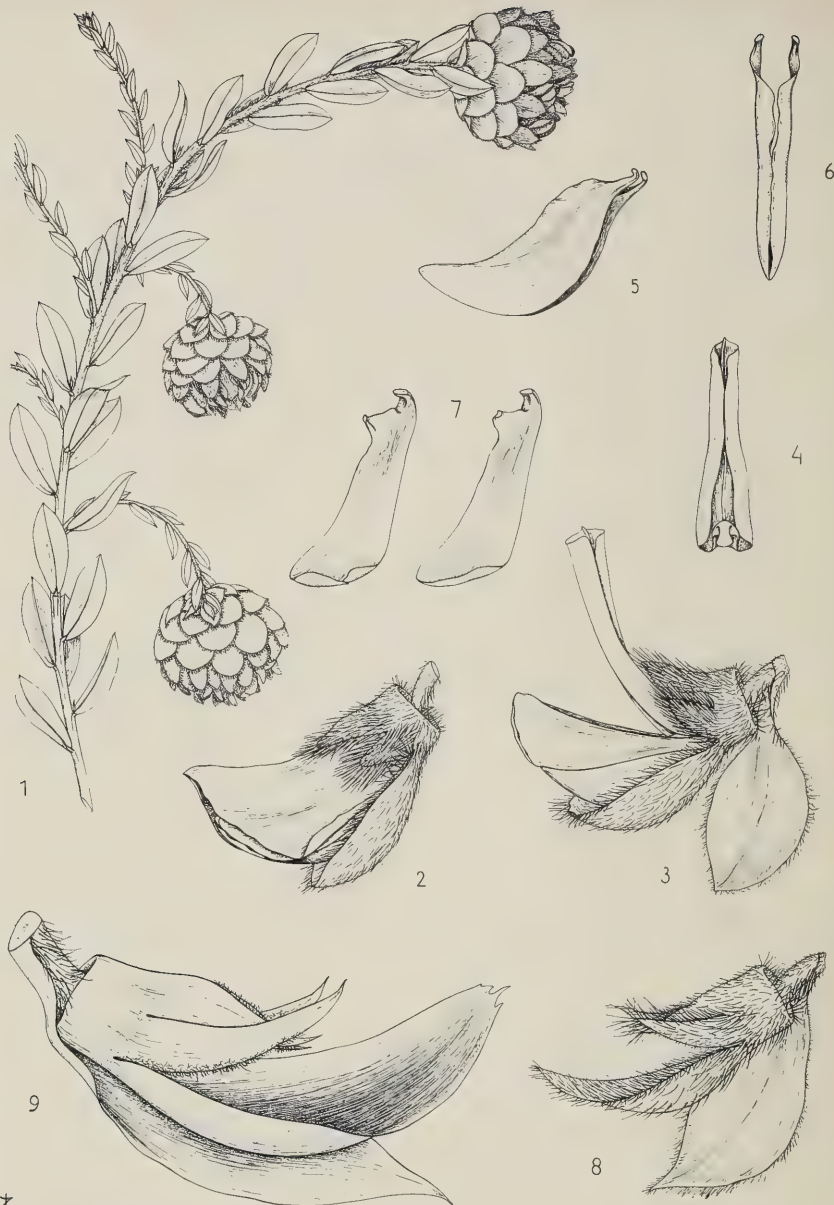


FIG. 4.

*Liparia parva* Vog. ex Walp. 1. flowering branch ( $\times \frac{1}{2}$ ); 2, 3. flower ( $\times 2$ ); 4. vexillum, adaxially ( $\times 2$ ); 5. carina, laterally ( $\times 2$ ); 6. carina, upper view ( $\times 2$ ); 7. alae, inner side ( $\times 2$ ). 1–7: J. Sidey 2142, neotype (S). *L. splendens* subsp. *comantha* (Eckl. et Zeyh.) J. J. Bos et De Wit. 8: calyx and bract ( $\times 2$ ). J. J. Bos 1392 (WAG). *L. splendens* subsp. *splendens*. 9. calyx and bract ( $\times 2$ ). J. J. Bos 681 (WAG).



glabrous even when young. Leaf axils usually glabrous, but small tufts of hair may be present. Stipules up to 1 mm long and occasionally spreading. *Leaves* usually small, but stouter and larger leaves are also present on some shoots, (10—) 15—30 (—35) mm long and (3—) 5—10 (—15) mm wide. Although usually spreading and pointing upwards, they sometimes may be rather distant, spreading in a horizontal plane or even strongly deflexed. Not always mucronate. Usually perfectly glabrous on the faces and often on the edges, that may be slightly scabrid, but young leaves may be hairy and remain so for some time, generally showing a tendency to remain hairy longer on the lower faces and the edges, while the upper face most often remains glabrous. They do not show more than 5 major veins, often only 3. *Inflorescence* terminal, when young shoots branch off and develop directly below it, it may look deceptively lateral. Usually nodding and hiding its flowers close to the ground, occasionally more or less upright. They are  $2\frac{1}{2}$ —4 cm long and 3—5 cm wide. *Bracts* conspicuous, at first usually pale green but soon turning, often to dark, maroon red in anthesis. The ones on the outside often suborbiculate and bluntly rounded without an apiculate tip to clearly apiculate, or narrower and more ovate, (10—) 15—20 (—21) mm long and 5—15 mm wide. Usually glabrous on the faces, but sometimes more or less hairy on the lower (=outside) face, especially at the base and along the centre. The edges are densely ciliate or only slightly fringed or even quite glabrous, sometimes only partly ciliate with glabrous tips or with few scattered hairs on the edges. *Calyx*  $1\frac{1}{2}$ —2 cm long, the tube 1—3 mm long and up to 5 mm wide, densely villous to sparsely hairy outside. The upper lobes are 6—8 mm long, about 2 mm wide, and connate up to  $\frac{1}{3}$  to slightly above  $\frac{1}{2}$  their length. They are villous outside, densely ciliate on the edges, inside densely villous to puberulous or occasionally glabrous but always glabrous in the connate part inside. The lateral lobes are similarly hairy, but usually slightly to considerably shorter than the upper pair, their length varying between 3—6 mm while they are as wide or but slightly narrower than the upper lobes. Lower lobe much larger (10—) 14—15 (—18) mm long and (4—) 6—8 (—10) mm wide, the tip simple and narrowly acute to bluntly rounded and distinctly 3-dentate (both extremes may be present within one inflorescence). The outside of this lobe usually forms the least hairy part of the calyx, being sparsely hairy to almost glabrous, mostly hairy in the lower  $\frac{1}{2}$  and almost glabrous in the upper part. The edges are usually ciliate, often densely so, occasionally only sparsely fringed. The inside is villous, usually only in the lower  $\frac{1}{2}$ , the upper part or only the tip but sparsely so, glabrescent or even glabrous. In fresh flowers the calyx may be pale green to yellow, the lobes towards their tip red to dark red. *Corolla* greenish to pale yellow in colour, lacking the red tinge and markings of the other species. *Vexillum* usually (13—) 18—20 mm long, with the two successive

perpendicular bends in the first 3 mm the total width amounts to 15 mm, but the lateral margins are extremely revolute and inrolled at the back leaving hardly any expanded part of the limb, thus being only 2—4 mm wide. The lateral margins entire and the part near the apiculate tip, that may be torn, usually slightly incurving. *Alae* usually slightly shorter than the vexillum, 15—18 mm long, very distinctly clawed, the limb rather abruptly widening and oblong rectangular in shape, 2—5 mm wide, the top end rather bluntly spathulate often lacking any lobes and usually not infolding each other like the other species, but merely touching, occasionally the lobes present and infolding, rarely 3 lobular edges interlocking in a bow-tie arrangement (see Fig. in the other species). *Carina* strongly falcate, with an almost perpendicular bend near the middle, occasionally only slightly so. Almost equal to the *alae*, the total length being about  $1\frac{1}{2}$  cm. These petals have a very narrow clawed base, after about 4 mm rather abruptly widening to 2—4 mm at its widest part, in the bend. The lower margins become connate in the upper  $\frac{1}{3}$  to  $\frac{1}{4}$ , usually about 4 mm below the tip, the upper may be connate in the middle third of their length, or for a few mm in that area, always leaving the base and the very tip free. *Stamens* enveloped by the *carina*, the sheath rather short, 10 mm, and disintegrating from 7 mm on. Their total length reaching some 18 mm but shorter in the smaller flowers. They are of the usual two kinds, but in a young flower a dissimilar arrangement was noticed: the anthers of the shorter kind (including that of the vexillar stamen) perched on top of shorter filaments instead of the usual arrangement with the shorter anthers on the longer filaments. In other cases the anthers were about 1 mm long and not clearly of two kinds. *Pistil* about as long as the stamens, the hairy *ovary* but minutely stipitate and about 7 mm long, with up to 7 (?8) ovules, the style and hairy capitate stigma as in the genus. *Pod* similar to the other species and of about the same dimensions,  $1\frac{1}{2}$ —2 cm long, about 9 mm high and flattened. Usually containing but one developed seed.

I have not seen any seedlings of this species.

#### DISTRIBUTION

From sea-level to over 300 m, restricted to the southern part of the Cape Peninsula (south of the line Chapman's Bay-Kalk Bay). One doubtful record from Klein River mountains (Caledon district). (Fig. 1).

**ECOLOGY.** Usually occurring in rocky places and on stony outcrops in the hills (Simonstown, Kommetjie) but occasionally in flats (Kommetjie). Solitary plants, or also as a few shrublets in a vegetation cover of equal height. Flowering specimens have been collected mainly in winter, i.e. between May and November, mostly in September, and rarely in November and May. One record of a flowering specimen collected in January.

**TIPIFICATION.** When publishing *L. parva*, Walpers referred to a MS. name by Vogel in the Kunth herbarium. Since this herbarium was destroyed at Berlin, and the small amount of material in the main Herbaria does not show any trace of having been studied for the original delimitation of the species, a neotype was proposed.

**POLLINATION.** Dr. Stephan Vogel (Bot. Stud. I: 211 (1954)) remarks that the flowers are pollinated by bees, also drawing attention to the smaller size of the flowers.

#### SPECIMENS EXAMINED

**CAPE PROVINCE.** Cape Point, *Andreae* s.n. (PRE), *Eames* s.n. (BOL). Plaatboom, *Compton* 13233 (NBG\*). Smith's farm, *Andreae* 580 (PRE), *Leighton* s.n. (BOL). Taylor's beach, *Taylor* 5289 (WAG\*). Buffelsbay, *Glover* s.n. (BOL). Smitswinkel, *Minicky* s.n. (SAM\*), *Penfold* s.n. (NBG\*), *Barker* 5910 (NBG\*). Simonstown mnts., *Bodkin* s.n. (BOL), *Bolus* 4953-Fair (BOL, PRE), *Bolus* 4953-A.B. (PRE), *Bolus* 4953-H., *Bolus* (BOL), *Marloth* 7789 (PRE\*), *Stokoe* s.n. (SAM\*), *Wolley-Dod* 1119 (BM\*, BOL), *Wright* 549 (TCD\*). Klawervlei, *Esterhuyzen* 12900 (BOL), *Wolley-Dod* 804 (BM\*, BOL). Klaarsjagersberg, *Sidey* 2142 (S\*, neotype) MO\*, WAG\*, PRE\*. Red Hill, *Bos* 350 (WAG\*), 682 (WAG\* + spirit coll.), 1407 (WAG\*), 1408 (WAG\*), *Rodgers* 11226 (PRE), *Pillans* 3416 (PRE). Between Scarborough and Red Hill, *Fischer* s.n. (SAM\*). Schuster's River, *Lam & Meeuse* 4107 (S\*, L\*, MO\*). Bonteberg, *Bond* 397 (NBG\*). Scarborough, *Hafström & Acocks* 2320 (S\*, PRE). Witsands, *Linley* s.n. (SAM\*), *Penfold* 265 (NBG\*), *Primos* s.n. (PRE), *Schmidt* 225 (M\*). Slangkop, *Lamb* 2100 (E\*). Kommetjie, *Barker* 5901 (BOL, NBG\*), *Bos* 1404 (WAG\*), 1405 (WAG\*), 1406 (WAG\*), *Galpin* 3902 (PRE), *Pillans* 10923 (MO\*). Glencairn, *Stokoe* 7820 (BOL\*). Fish Hoek, *Acocks* 2561 (S\*), *Andreae* 571 (PRE\*).

**UNCERTAIN LOCALITIES.** *Boivin* 569 (TCD\*). "C.B.S.", *Brossard* s.n. (P\*). Cap de Bonne Espérance, *Brown* s.n. (E\*). S. Africa, *Carmichael* s.n. (TCD\*). Cape of Good Hope, *Forbes* s.n. (K\*). "C.B.S.", *Forbes* 286 (BM\*). "C.B.S.", *Grey* s.n. (K\*). S. Africa, *Krauss* s.n. (NY\*), "Uitershoeck" (type of *L. crassinervia* Meisn.), *Marloth* 7789b (PRE\*). From Cape Town Flower Show 1919, Herb. *Retzius* (LD\*). "C.B.S.", ?*Thunberg* s.n. (S\*).

*Stokoe* 7822 (BOL) from Klein River mnts., Caledon district, was not closely examined by me; if it belongs to *L. parva* Vog. ex. Walp., the locality may prove to be erroneous, since *Stokoe* no. 7820 was collected on the Cape peninsula near Glencairn (see above).

## ACKNOWLEDGMENTS

I am much indebted to Prof. Dr. H. C. D. de Wit and his staff for their guidance, advice and facilities rendered. Prof. Dr. P. G. Jordaan for hospitality and assistance at the Dept. of Botany, University of Stellenbosch, Dr. F. A. Stafleu for his advice, and the Directors and Keepers of the following Herbaria for the loan of herbarium specimens or permission to consult their collections: Berlin (B), Cape Town (BOL, NBG, SAM), Dublin (TCD), Edinburgh (E), Firenze (FI), Genève (G), Göttingen (GOET), Hamburg (HBG), Kew (K), Leiden (L), London (BM), Lund (LD), München (M), New York (NY), Paris (P), Pretoria (PRE), St. Louis (MO), Stockholm (S), Stellenbosch (STE), Uppsala (UPS), Wrocklaw (WRSL).

## PLANTAE NOVAE AFRICANAE

"Ex Africa semper aliquid novi"—*Pliny*.

### SERIES XXXII

R. H. COMPTON

In the course of my work in the Botanical Survey of Swaziland more than a hundred apparently undescribed species have been collected. In my "Annotated Check List of the Flora of Swaziland" (Journ. S.A. Bot., Suppl. Vol. VI, 1966) these were mentioned by the collector's name and register number at the end of the lists of species in their respective genera.

In the following pages some of these *novitates* are now named and described with references to specimens. The Swaziland specimens are included in the Herbarium which has been built up during the progress of the Survey: duplicates of most of them have been placed in the Compton Herbarium, National Botanic Gardens, Kirstenbosch, and in the Herbarium of the Botanical Research Institute, Pretoria. To the heads and staffs of these two Herbaria I am grateful for the invaluable assistance they have given me throughout my work on the flora of Swaziland.

Some of the species described also occur outside Swaziland, and it is to be expected that others as well will be found outside the political boundary of the territory.

There remains a considerable number of undescribed or inadequately known plants in the Swaziland Herbarium: these must await further investigation or the collecting of fuller material before they can properly be published. It is also certain that with further work many additions will be made to the list of plants known to occur in this small but botanically rich and diversified country, and among these will be a proportion of new species.

**Eucomis montana** Compton (Liliaceae).—*Bulbus grandis, e terra multo exserta. Folia magna, multifaria, erecto-patentia, late ovata, non undulata, base lata, apice obtusa, laevia, multinervata, viridia, inferne maculata. Inflorescentia erecta, parte superiore florifera, in comam terminalem foliorum excurrens. Flores dense inserti, erecto-patentes, perianthio viride, segmentis breviter*



conjunctis, oblongis, obtusis: filamenta fusca, in tubo perianthii inserta, base connata, antheris versatilibus: ovarium fuscum, late ovoideum.

Bulb large, truncated, half or more above ground. Leaves multifarious, erect spreading, broadly ovate, broad-based, up to 50 cm long, 18 cm wide, not undulate, the apex obtuse, green, the surface smooth, spotted or speckled beneath, especially near the base, the veins very numerous, parallel, closer in the middle forming a flat banded midrib. Inflorescence axis about 30 cm high, the lower half uniformly c. 1 cm diam, the upper half slightly thicker and bearing numerous closely-set flowers which stand in an erecto-patent position. Bracts membranous, broad-based, c. 1 cm long  $\times$  7 mm wide. Pedicels 3—5 mm long. Perianth green, up to 2 cm long, the segments united shortly, half-spreading, oblong, obtuse, faintly veined. Filaments dark brown, inserted on the tube, connate at the base, tapering uniformly to the tip which reaches to c. 5 mm below the tip of the perianth segments and bears the short versatile anther. Ovary dark brown, broadly ovoid, narrowing sharply to the style which is about the same length as the stamens and ends in a small capitate stigma. The inflorescence ends in a dense tuft of broadly ovate green leaf-like bracts c. 5 cm long  $\times$  2 cm wide with obtuse tips.

A large and handsome plant, little known in the wild state and hitherto placed under *E. undulata*. Ait. from which, however, it differs in several respects, as follows. It is a social plant, not solitary: it occurs in companies in the partial shade of boulders and not as solitary individuals in the open veld: its leaves are much larger, relatively broader, standing semi-erect, not at all undulate: the inflorescence is shorter than the leaves, the individual flowers being erecto-patent, not drooping: the stamen filaments broaden uniformly from the apex to the base where they are connate round the ovary: the leaf-like bracts of the coma are larger and relatively broader.

HAB. Swaziland, near Devil's Bridge in the Emlembe Mountains, c. 5,000 ft alt., *Compton* 29398 (type). Cultivated for several years in a garden in Mbabane, where it flowered regularly in January from 1960 to 1963, keeping its characters distinct from adjoining plants of *E. undulata*.—*Van der Merwe* 1250 (PRE) from Belfast, E. Transvaal, is apparently the same.

**Kal'nchoe decumbens** *Compton* (Crassulaceae).—Radix perennis, ramis decurrentibus, inflorescentia erecta, ubique glaber. Folia succulenta, numerosa, plerumque in caulis parte horizontale, irregulariter disposita, resupinata, anguste lanceolato-clavata, obtusa. Panícula parva, subcapitata, sepalis liberis, corolla cinnabarina, base ventricosa, fauce contracta, lobis patentibus.

Rootstock perennial, branches spreading horizontally becoming erect and ending in an erect inflorescence. Leaves mainly on the horizontal part of the stem, succulent, numerous, crowded, scattered, seldom in pairs, erect, narrowly

lanceolate-clavate, obtuse, up to c. 35 mm long  $\nearrow$  5 mm wide above the middle, tapering gradually to the narrow insertion on the stem. Inflorescence erect with a few pairs of reduced leaves near its base, mostly bare, up to c. 30 cm high, ending in a small subcapitate erect panicle. Pedicels c. 3 mm long. Sepals free to the base, c. 3 mm long  $\times$  1 mm wide. Corolla c. 1 cm long, c. 4 mm wide at its ventricose base, narrowing to a small throat at which the anthers and stigmas appear, the lobes patent, ovate, obtuse, c. 6 mm long  $\times$  3 mm wide, cinnabar-red. Carpels free to the base, c. 5 mm long, tapering gradually to minute capitate stigmas: ovules numerous.

HAB. Swaziland. Hill at entrance to Ingwavuma Poort, Lebombo Range, c. 2,000 ft alt., *Compton* 29407 (type). Flowered in cultivation at Mbabane in April.

***Kalanchoe montana*** Compton (Crassulaceae).—Robusta, succulenta, ubique minute glanduloso-puberula. Folia basalia caulinaque integra, oblanceolata, apice rotundata, molliter succulenta. Inflorescentia interrupta, thyrsioidea, cum ramis axillaribus. Flores dense aggregati, pedicellis brevissimis, sepalis liberis lanceolatis acutis, corolla viride-flava, parum obliqua, ovoidea, fauce haud contracta, lobis erecto-patentibus, antheris breviter exsertis.

A robust succulent plant forming a rosette of basal leaves from which arise the spreading or decumbent stems which bear a few distant pairs of leaves and end in elongated interruptedly thyrsoid panicles with axillary branches. Stem fleshy, minutely puberulous with spreading gland-tipped hairs. Leaves simple, obovate to oblanceolate, rounded at the apex, tapering uniformly to a narrow base, softly succulent, the margins sometimes slightly undulate, the surfaces very minutely puberulous, diminishing in size along the stem into the panicle, the largest c. 18 cm long  $\times$  7 cm wide above the middle. Panicle about equal in total length to the sterile part of the stem, the axillary branches erect: the flowers in dense spreading clusters, the individual flowers erecto-patent at anthesis, the bracts and axes minutely glandular-puberulous. Pedicels very short. Sepals free to the base, lanceolate, acute, minutely puberulous, c. 9 mm long  $\times$  3 mm wide. Corolla greenish-yellow, slightly asymmetrical, ovoid, scarcely narrowed at the throat, the tube c. 13 mm long  $\times$  5 mm wide, the lobes erecto-patent, slightly turned upwards, c. 5 mm long  $\times$  2 mm wide, scarcely acute. Anthers shortly exserted from the corolla tube. Carpels with slender styles and minute capitate stigmas within the corolla tube.

HAB. Swaziland. Near Devil's Bridge, Emlembe Mountains, c. 5,500 ft alt., *Compton* 29471 (type). Flowered in a Mbabane garden for several years in March and April.

*Codd* 9798 from 1 mile east of Pilgrim's Rest, E. Transvaal, on steep rocky

hillsides, which flowered in hort. PRE in February 1957, appears to be this species.

**Pearsonia mbabanensis** Compton (Papilionatae).—Radix perennis lignosa, caulibus foliosis annuis flexuosis paucis, ubique, foliae superficies superior corollae exceptae, pilis densis subappressis vestitis. Folia trifoliata, irregulariter disposita, erecto-patentia, brevissime petiolata, segmentis oblanceolatis, frequenter plicatis. Racemae paucae, laterales. Calyx tubo campanulato, lobis lateralibus latis, anteriore anguste triangularibus. Corolla flava, vexillo infra serico, aliter glabra. Siliqua compressa, stylo persistente.

Woody perennial rootstock from which a few flexuous annual stems arise to c. 30 cm or less, dividing about the middle, mostly leafy towards the end with one or two lateral flowering shoots up to c. 8 cm long. Stems, underside of leaflets, calyces and fruits densely clothed with appressed or somewhat spreading russet hairs, the upper side of the leaflets almost glabrous. Leaves trifoliate, irregularly spaced on the stem, erecto-patent, very shortly petiolate, the leaflets oblanceolate, often infolded lengthwise, the median slightly the largest, up to 15 mm long  $\times$  4 mm wide. Floral bracts linear, 3 mm long. Calyx tube campanulate, c. 8 mm long; lateral teeth in pairs, broadly triangular, 1 mm long; lowest tooth narrow-triangular, acute, 2 mm long. Corolla yellow, glabrous except for silky hairs on the back of the vexillum. Vexillum shortly stalked, gradually broadening to an obtuse reflexed lamina c. 1 cm long  $\times$  5 mm wide. Alae with narrow stalks 6 mm long, the laminae 5 mm long  $\times$  3 mm wide. Carina with stalks 4 mm long and laminae 4 mm long. Stamens 8 mm long. Ovules about 7. Mature fruit flattened, 2 cm long  $\times$  5 mm wide, densely appressed-hairy, tipped with the persistent style.

HAB. Swaziland, Mbabane District. Frequent in high-veld grassland, flowering September to November. Near Poliniane River, c. 4,000 ft alt., *Ben Dlamini* s.n. 6.9.60 (type); same locality and collector, 9.10.58: Palwane, c. 3,500 ft alt., *Compton* 30766: Ukutula, c. 4,000 ft alt., *Compton* 25203.

**Cassipourea swaziensis** Compton (Rhizophoraceae).—Arbor parva, ramosa, sempervirens. Folia numerosa, opposita, coriacea, breviter petiolata, lamina ovata vel late lanceolata, utrinque glabra, sed mesonervo petioleque infra puberulis. Flores in axillis aggregati: sepala anguste triangularia, externe fulvo-hirsuta: petala alba, anguste spathulata, apicibus fimbriatis: stamina c. 15: ovarium albo-setosum: stigma breviter 3—4-lobatum: ovula pauca.

A small much-branched tree. Stems hairy when young, the surface fissured lengthwise and crosswise as they grow. Leaves borne at frequent intervals, opposite, coriaceous, the petiole short, densely hairy, the lamina ovate or broadly lanceolate, c. 7 cm long  $\times$  3 cm wide, obtusely apiculate, glabrous above and below, the midrib prominent below with a few scattered hairs. Stipules

interpetiolar, narrow, hairy, caducous. Flowers in axillary clusters, scented. Bracts short, rigid, forming a globular envelope to the base of the pedicel which is c. 5 mm long. Calyx tube campanulate, c. 2 mm long, lobes 5, valvate, narrow-triangular, c. 8 mm long, spreading widely, fulvous-hairy outside. Petals 5, white, narrowly spatulate, the lamina c. 5 mm long with the apex fringed with 5—10 very narrow laciniae c. 2 mm long. Stamens about 15, filaments filiform, c. 7 mm. long, inserted below the many-pointed rigid disc, the anthers curved, c. 1 mm long. Ovary partly sunk in the disc, covered with stiff white setae which tip the partly grown fruit, the style c. 4 mm long with a shortly 3—4-lobed stigma, ovules few.

HAB. Swaziland. Near Mhlosheni, Hlatikulu District, c. 3,000 ft alt. on rock outcrops. Flowering in October. *Compton* 29245 (type), 29685.

**Epilobium karsteniae** Compton (Onagraceae).—Perennis, rhizoma horizontale, nodosa, caulibus annuis herbaceis simplicibus foliosis, ubique griseo-puberulis: caulis teres: folia erecto-patentia, sessilia, linearilanceolata, sparse callosodenticulata: flores axillares, singulares: sepala angusta, acuta: petala pro genere magna, rosea, venosa, emarginata.

A perennial with horizontal jointed rhizomes from which arise erect unbranched (or slightly branched in the terminal inflorescence region) annual shoots which are closely leafy from bottom to top. All parts, except the petals, finely grey-puberulous. Stem terete, up to 3 mm diam, slightly thicker near the base, reaching 120 cm high, usually less. Leaves numerous, erecto-patent, sessile, linear-lanceolate, entire but sparsely callous-denticulate, up to 4 cm long / 5 mm wide, the veins prominent below, slightly sunken above. The terminal 5—10 cm of the shoot bears the solitary axillary flowers. Pedicels c. 1 cm long, the ovary inferior, c. 2 cm long, elongating to c. 6 cm long at maturity. Sepals linear, acute, 12 mm long. Petals magenta, much-veined, 15 mm long and wide, deeply emarginate, spreading. Stigmas 4. Seeds 1 mm long with a tuft of fine silky hairs.

HAB. Swaziland. Swamps near Forbes Reef, Mbabane District, 4,500–5,000 ft alt. Flowers in January and February. *Karsten* s.n. 21.2.64. *Compton* 30487 (type), 31256.

Named in compliment to Miss Mia C. Karsten, the botanical historian, who has greatly assisted me in collecting, secretarial and herbarium work.

**Alepidea parva** Compton (Umbelliferae).—Perennis, exilis, glaber: folia basalia, petiolis longis, laminis ovatis, marginibus dense longe-setiferis: capitula parva, pauca, plerumque 2.

A small perennial plant with a slender rhizome, glabrous except for the setae on the leaf-margins. Leaves numerous in a dense basal rosette, spreading or reflexed, the petiole slender, 2 cm long or less, abruptly widening to the oval



lamina which is up to 2 cm long  $\times$  about 8 mm wide, flat, obtuse, paler beneath, closely fringed with numerous tapering setae up to 5 mm long, sometimes longer. Stem erect, slender, up to 20 cm high, bearing a few narrow appressed vestigial laminae closely fringed with long setae. Capitula usually 2, the peduncles with minute bracts at the middle. Involucre wide-spreading, c. 15 mm diam, the bracts lanceolate, acute or apiculate, white above, 5 of them shorter and alternating with the other longer 5, 3—5-veined below; an occasional marginal seta may be present. Flower-cluster dense, c. 4 mm diam.

HAB. Swaziland. Ngwenya Mountains, Mbabane District, on rock outcrops, c. 5,000 ft alt. Flowering in March. *Compton* 26735 (type): *A. Meeuse*, 10119, same locality and date, 8.3.57 (PRE).

***Cephalaria foliosa*** Compton (Dipsacaceae).—Perennis, erecta, robusta: caulis costatus, sub nodis villosus, aliter glaber: folia caulina decussata, sessilia, ovata, utrinque glabra, marginibus serratis, apice anguste acuta: inflorescentiae axes axillares vel terminales parum ramosi: capitulum convexum: bracteae exteriores orbiculares, obtusae, subglabrae, marginibus ciliatis, interiores acutae, sericae: corolla alba infra dense serica.

A robust erect perennial plant up to 150 cm high. Stem ribbed, with numerous hairs below the nodes, otherwise glabrous or nearly so. Leaves in decussate pairs, spreading or erecto-patent, widely spaced on the stem, sessile, ovate, serrate with forward-directed teeth, tapering to a narrow acute toothless apex, glabrous on both sides, up to c. 15 cm long  $\times$  6 cm wide. Inflorescence terminal and from the axils of the upper reduced leaves, the axes forking once or twice, the ultimate peduncles up to 20 cm or more long, with one or two pairs of minute bracts. Capitula 20—25 mm diam, dome-shaped: outer bracts orbicular, obtuse, almost glabrous, the margins ciliate: inner bracts acute, silky: corolla densely silky below, white.

HAB. Swaziland. Growing socially in highveld swamps and near streams. Mbabane District: Fyfes, c. 4,500 ft alt., *Compton* 26807 (type); Forbes Reef, c. 5,000 ft alt., *Compton* 30555; Red Hill Road, c. 3,500 ft alt., *Compton* 31374; Dalriach, c. 4,000 ft alt, *Dlamini* s.n. 13.4.61. Mankaiana District: near Mankaiana, c. 4,000 ft alt., *Compton* 28779. Flowering in March and April.

***Cephalaria petiolata*** Compton (Dipsacaceae).—Perennis, rhizoma sub-tuberosa: folia pauca, petiolis elongatis angustis, laminis lanceolatis acutis, integris sed dentibus parvis, paucis, sparse pilosis: caulis erectus, angustus, plerumque simplex, capitulum unicum terminalem gerens, interdum ramis lateralibus: capitulum convexum, bracteis exterioribus orbicularibus obtusis fuscis, interioribus angustioribus acutis, omnibus sericis: corolla exserta, alba, externe villosa.

Perennial with a cylindrical or somewhat tuberous rhizome. Aerial shoot



solitary. Leaves few, usually 4—6, the petioles slender, erect, up to 15 cm long, gradually widening to the lamina which is lanceolate, acute, entire or with a few short marginal teeth, sparsely hairy on one or both surfaces, up to 9 cm long 3 cm wide, usually much less, the midrib prominent. Stem erect, slender, glabrous, slightly ridged, usually unbranched, sometimes with one or two lateral branches rising from the axils of linear or pinnatisect bracts, up to 70 cm high with a terminal dome-shaped capitulum about 3 cm diam, the lower bracts dark-coloured, orbicular, obtuse, c. 3 mm wide, the upper bracts rather narrower and acute, all silky-hairy: corolla well-exserted, white, hairy outside.

Distinguished by its long slender petioles, almost entire nearly glabrous laminae, the usually unbranched slender stem bearing a single capitulum, and the late summer flowering habit (March and April).

HAB. Swaziland. Mbabane District: swamps near Forbes Reef, c. 4,500 ft alt., *Compton* 25740 (type), 32335.

***Wahlenbergia pinnata*** *Compton* (Campanulaceae).—*Suffrutex erecta gracilis*, e base multiramosa, glabra, foliis numerosissimis, plus minusve imparipinnatis, lobis breviter filiformibus, inflorescentia copiose divaricato-ramosa.

Small perennial rootstock from which arise numerous erect slender rather rigid simple or branched glabrous shoots 30—45 cm high, the lower part copiously leafy, the leaves becoming fewer and smaller in the upper half which is mainly inflorescence. Leaves very slender, 5 mm long more or less, sometimes up to 1 cm long, imparipinnate, the 2—4 lateral lobes opposite or subopposite, the rachis and lobes filiform, minutely apiculate, the upper leaves often merely slightly 3-lobed at the tip. Inflorescence a much-branched rather tangled cymose panicle, the branches subtended by filiform simple or slightly lobed bracts, the very slender axes diverging at about a right angle, the terminal parts of the inflorescence having a false-dichotomous appearance. Calyx 3 mm long, the lobes slightly recurved, apiculate. Corolla narrowly campanulate, pale blue, the tube c. 5 mm long, the lobes 2 mm long.

HAB. Swaziland, especially on rocky outcrops, flowering in March. Mbabane District: Hills W. of Mbabane, c. 4,500 ft alt., *Compton* 25723 (type); Stroma, c. 4,000 ft alt., *Compton* 25726; Hills NE. of Mbabane, c. 4,500 ft alt., *Compton* 29962; Ngwenya Mountains, c. 5,000 ft alt., *Compton* 26746, 31403; Fonteyn, c. 4,500 ft alt., *Compton* 31382.

var. ***simplicifolia***.

*Planta typica similis, sed foliis integris, filiformibus.*

Distinguished from the typical variety in having simple, undivided filiform leaves, but not separable otherwise. Also flowers in March.

HAB. Swaziland. Pigg's Peak District, Havelock Road, c. 4,000 ft alt., *Compton* 27683 (type); Pigg's Peak, c. 4,000 ft alt., *Compton* 28724; Havelock,

c. 4,000 ft alt., *Compton* 29967.

**Eumorphia swaziensis** Compton (Compositae).—Frutex parvus, dense ramosus, plerumque glaber. Caules erecti, lignosi. Folia parva, numerosissima, erecto-patentia, plerumque ultra medium trifida, lobis filiformibus, apiculatis, nonnulla integra. Inflorescentia irregulariter corymbosa. Capitula numerosa, erecta, breviter pedunculata, pedunculo bracteisque sparse villosis. Involucrum compactum, campanulatum, bractearum marginibus anguste membranaceo-fimbriatis. Flosculi radii 5, feminei, albi, breviter 3-lobati, tubo sparse glanduloso, pappo nullo, disci hermaphroditi, tubo glanduloso, antheris breviter apiculatis, pappo nullo: paleae lineares, membranaceae.

A small mainly glabrous shrub, 30–60 cm high, with erect woody stems, densely branched in the upper floriferous parts. Leaves very numerous, erecto-patent, mostly trifid just above the middle, the rachis and lobes filiform, flexuous, apiculate, the lobes subopposite, total length c. 2 cm: many of the leaves in the upper parts of the stems undivided, filiform, about half as long. Inflorescence irregularly corymbose, the capitula numerous, erect, each borne on a peduncle a few mm long, subtended by a short linear bract: the peduncle and bract finely and sparsely hairy. Involucre c. 5 mm long  $\times$  2 mm diam, compact, campanulate, glabrous, the margins of the inner bracts narrowly membranous-fimbriate. Ray florets 5, female, the lamina broadly oblong-ovate, c. 3 mm long  $\times$  2 mm wide, obtuse, shortly 3-lobed, glabrous, white, the tube sparsely glandular, the ovary slightly striate, pappus absent: disc florets bisexual, the styles linear, truncate, the anthers with short appendages, the tube glandular, the ovary linear, slightly striate, pappus absent: paleae membranous, linear, slightly shorter than the ray florets. Flowers in March and April.

HAB. Swaziland. Mbabane District: Hill NE. of Mbabane, c. 4,500 ft alt., *Compton* 29963 (type).

**Senecio eminens** Compton (Compositae).—Perennis, erecta, robusta, glabra. Folia basalia longe anguste petiolata, laminis lanceolatis, obtusis, minute obtuse cartilagineo-dentatis, caulina sessilia, mesonervo marginibusque decurrentibus. Inflorescentia irregulariter corymbosa. Capitula pauca, magna, discoidea, involucri bracteae c. 21, marginibus membranaceis, apicibus acutis: flosculi numerosissimi, plus quam 300, albid: pappus subrigidus, sericus, albus.

A robust erect perennial, glabrous throughout, reaching 120 cm high. Basal leaves with a slender petiole up to 20 cm long, gradually widening to a lanceolate lamina up to 25 cm long., obtuse, minutely bluntly cartilaginous-dentate, the midrib prominent below extending to the leaf apex. Cauline leaves shorter and narrower, sessile, the margins and midrib decurrent forming ridges on the stem. Inflorescence axillary and terminal forming an irregular corymb of a few capitula, the peduncle bearing a few small distant linear bracts becoming closer

below the involucre. Capitulum up to 35 mm diam, the main bracts about 21, linear with membranous margins, narrowing to an erect acute apex as long as the florets, c. 2 cm long. Ray florets absent. Disc florets very numerous, over 300, the corollas whitish, 15 mm long. Pappus stiff, silky white. Flowers in March.

HAB. Swaziland. Mbabane District: Ngwenya Mountains, c. 4,500 ft alt., *Compton* 26740; Black Mbuluzi Valley, c. 3,500 ft alt., *Compton* 25031. Mankaiiana District: 10 miles E. of Mankaiiana, c. 4,000 ft alt., *Compton* 28672 (type).

A conspicuously robust plant, strong specimens having remarkably large discoid capitula.

***Senecio mbuluzensis*** *Compton* (Compositae).—Perennis, erecta, robusta, plerumque glabra. Caulis rigidus, costatus. Folia caulina sessilia, lanceolata, marginibus minute calloso-denticulatis. Inflorescentia laxa corymbosa: capitula pauca, magna, bracteis basalibus paucis, involucri c. 13, acuminatis: flosculi radii c. 8, flavi, feminei, disci c. 34: pappus copiosus, subfuscus.

A rhizomatous perennial 90—150 cm high, finely puberulous on the lower part of the stem, the leaf margins, the midrib below and the tips of the involucreal bracts, otherwise glabrous. Stem erect, rigid with numerous thicker or thinner ribs decurrent from the leaf-bases. Leaves numerous, overlapping, sessile, not stem-clasping, erecto-patent, lanceolate, the margins minutely callous-denticulate, the median c. 8 cm long  $\times$  2 cm wide, the lowest rather smaller, the uppermost smaller and more distant as they subtend the branches of the inflorescence. Inflorescence loosely corymbose, its axes simple or occasionally forked, elongated, usually without bracts. Capitula few, relatively large. Basal involucreal bracts few, narrow: main involucreal bracts c. 13, up to 15 mm long, the apex long-acuminate, erect. Ray florets c. 8, female, yellow, the lamina wide-spreading, up to 15 mm long  $\times$  3 mm wide. Disc florets numerous, c. 34, corolla c. 1 cm long. Pappus copious, slightly brownish. Flowers from October to January or at other times following burning.

HAB. Swaziland. Highveld or middleveld, especially in slightly damp places, local but social. Mbabane District: Ukutula, c. 4,000 ft alt., *Compton* 25259; Black Mbuluzi Valley, c. 3,500 ft alt., *Compton* 32180 (type), 28254, 32106; Malandela, c. 4,000 ft alt., *Compton* 31889; Usutu Canal, c. 2,500 ft alt., *Compton* 27115; Hill NE. of Mbabane, c. 4,000 ft alt., *Compton* 28243. Manzini District: Malkerns, c. 2,500 ft alt., *l'Ons* 60/53. Hlatikulu District: Hlatikulu, c. 4,000 ft alt., *Compton* 29501.

Transvaal. Barberton District: 10 miles SE. of Barberton, on road from Barberton to Havelock, 4,000 ft alt., 9.12.53, *Codd* 8171 (PRE); Barberton, Dec. 1912, *R. Pott* 5432 (PRE). Nelspruit District: Slopes of Amajuba Mountain, Schagen, 4,000 ft alt., *Liebenberg* 3104 (PRE).

***Senecio mlilwanensis*** *Compton* (Compositae).—Erecta, robusta, ubiqua

lanosa: folia elongata, angusta, sessilia, marginibus in caule decurrentibus, coriaceis, minute crenulatis: inflorescentia ramosa, subcorymbosa: capitula plurima, magna: bracteae basales numerosae, exteriores expansae vel reflexae, involucri c. 18: flosculi radii c. 8, flavi, disci c. 60—80: pappus mollissimus.

A tall erect herbaceous plant, up to 180 cm high, unbranched except in the region of the inflorescence, covered with a loose pale greyish woolly indumentum throughout except on the undersurfaces of the leaves where the wool is closely and thickly felted. Stem with several sharp-edged ridges decurrent from the leaf-bases. Leaves numerous, soft-textured, linear or narrowly linear-lanceolate, tapering gradually to a sessile base and to an attenuated apex, the midrib prominent below, the margin coriaceous, finely crenulate, the largest leaves up to 30 cm long  $\times$  25 mm wide, mostly shorter and narrower. Inflorescence terminal with up to 80 capitula, usually less, loosely corymbose, irregularly branched with narrow leaf-like subtending bracts. Capitulum c. 15 mm long, the basal involucrel bracts numerous, linear, spreading, reflexed or twisted, the inner ones imbricating with the main bracts which number c. 18. Ray florets 8, yellow, the lamina c. 8 mm long. Disc florets numerous, c. 60—80. Pappus very soft, greyish white. Flowers in February and March.

HAB. Swaziland. Mbabane District: Black Mbuluzi Valley, c. 3,500—4,000 ft alt., *Compton* 27593 (type), 25029, 25689; Dalriach, bushy places near rocks, c. 4,500 ft alt., *Compton* 28562; Mbabane, hill-top, c. 4,500 ft alt., *Dlamini* s.n. 20.2.61; Mlilwane Game Sanctuary, *E. Reynolds* s.n., March 1967.

A distinctive and conspicuous plant, usually occurring singly in bushy places: has some affinity with the problematic *S. albanensis* DC.

**Senecio swaziensis** *Compton* (Compositae).—Perennis, ubique glaber, caulis basis lanata excepta, glauca. Caulis simplex, foliis paucis, subrigidis, sessilibus, orbicularibus vel late ovatis, amplexicaulibus, obtusis, mesonervo infra prominente, margine anguste coriacea, dentibus numerosis, densis, acute triangularibus. Inflorescentia iterum ramosa, ramis erectis, laxe subcorymbosa. Capitula erecta. Bracteae basales paucae minutae, involucri c. 8, lineares, truncatae sed apiculatae. Flosculi radii 0, 1, 2 vel 3, flavi, disci c. 13. Pappus copiosus albus.

Perennial. Rhizome usually producing a single erect annual shoot. Base of the stem where it joins the rhizome shortly woolly, otherwise the whole plant completely glabrous. Usually 60—90 cm high, the lower half unbranched, bearing a few (4—7) sessile, glaucous, rather stiff leaves, which are amplexicaul, the lamina orbicular or very broadly ovate, obtuse, the midrib prominent beneath extending to the apex, the margin narrowly coriaceous with numerous close-set sharply triangular teeth, mostly c. 2 mm long. Above the middle the stem branches repeatedly, the branches being semi-erect, and all ending at about



the same height in a loosely corymbose inflorescence. Capitula upright. Involucre obconic, c. 8 mm long, with a few minute basal bracts and about 8 main bracts which are linear, broadening to a pair of shoulders and terminating in an acute apex. Ray florets either absent or one or two, rarely three, ligulate, yellow, c. 8 mm long. Disc florets c. 13, the pappus copious, white. Flowers in November and December.

HAB. Swaziland. Mbabane District, locally abundant. Near Mbabane, c. 4,000 ft alt., *Compton* 31833 (type); Hill NE. of Mbabane, c. 4,500 ft alt., *Compton* 27207, 27246; Hill N. of Mbabane, c. 4,000 ft alt., *Dlamini* s.n. 6.12.60; Ukutula, c. 4,000 ft alt., *Compton* 25258. Hlatikulu District, 4 miles N. of Mahamba, 3,300 ft alt., *Acocks* 15328.

A very distinctive species, apparently confined to Swaziland or almost so, locally abundant, especially in the neighbourhood of Mbabane, on rocky ground in the highveld.

The great majority of the capitula are discoid, with from 9 to 13 florets. Forty-seven capitula showing ray-florets were examined: of these three had three rays, ten had two rays and 34 had one ray. The number of disc florets in these radiate capitula varied from 7 to 15, with no clear relation to the number of ray florets.

***Senecio viscidulus*** Compton (Compositae).—Perennis, ubique viscidula, copiose glandulo-pilosa: folia plerumque basalia, petiolis longitudine variis, laminis multiformis, obtusis, crenulato-dentatis: caules irregulariter pauciramosi: capitula discoidea: bractee basales paucae, involucri c. 13, attenuatae: flosculi c. 34, fusco-aurantiaci.

A weak tufted perennial, all vegetative parts viscidulous with abundant short gland-tipped hairs. Leaves mostly basal, petiolate, the petioles variable in length up to c. 7 cm, broadening gradually to laminae which vary from lanceolate to ovate and even orbicular up to c. 8 cm long, coarsely and irregularly crenulate-dentate, obtuse. Stems often several from one tuft, slender, loosely and irregularly branched, sometimes from near the base, often bearing near the base one or a few sessile stem-clasping leaves, smaller and narrower than the basal leaves: height up to 45 cm, usually much less. Peduncle bearing a few small linear bracts. Capitula rayless, diam c. 12 mm, basal bracts very few, main bracts c. 13, c. 9 mm long, attenuate: disc florets c. 34, the corolla dull orange-coloured: pappus scanty, soft. Flowers from August throughout the summer.

HAB. Swaziland. Mbabane District: Ngwenya Mountains, c. 5,000 ft alt., *Compton* 26335; Bomvu Ridge, rock crevices, c. 5,500 ft alt., *Compton* 31188; Waverley Mine, c. 5,000 ft alt., *Compton* 26102; Forbes Reef, c. 4,500 ft alt., granite outcrop, *Compton* 31801; Ukutula, c. 4,000 ft alt., peaty rocks, *Compton* 25218. Pigg's Peak District: Havelock Road, c. 4,500 ft alt., rocks, *Compton*



27973 (type). Hlatikulu District: Hlatikulu, c. 4,000 ft alt., *Compton* 26258.

This plant corresponds fairly well with the description of *S. serratus* Sond., in Fl. Cap. III. 366 (under which species it has been placed provisionally in PRE, though other specimens so placed are clearly different), but I have not seen an authentic specimen. Harvey writes under *S. serratus* "Cape. Thunberg!, E. and Z. !; Camiesberg, Drège; Zululand, Gerr. and McKen 1013 (Herb. Sond. D.). I do not find this in Herb. Thunb. but a specimen of Thunberg's collecting (Hb. Sond.) quite agrees with those of Ecklon and Drège. Gerrard's specimen has rather narrower leaves but does not otherwise differ."

It seems very unlikely that the Cape and Khamiesberg plants should be identical with the Swaziland plant, and it is therefore desirable to describe the latter as a new species.

## NOTES ON MESEMBRYANTHEMUM AND ALLIED GENERA

H. M. L. BOLUS

**Conophytum burgeri** L. Bol., sp. nov.—Plantae 2 visae, e corpusculo singulo compositae; corpusculum globose conicum, glabrum, inferne minute papillatum, papillis crebris, nitentissimis viridibus, superne subfenestratum, 1·3—1·8 cm. longum, prope basim ad 2 cm. diam., ore ca. 3—4 mm. longo; flos 1 visus, diurnus; pendunculus 1·4 cm. longus, prope basim bracteatus, bracteis obtusis, 3 mm. longis cum vagina 2 mm. longa; receptaculum 1·5 mm. longum, 2·5 mm. diam.; calycis tubus 4 mm. longus, segmentis 6, obtusis, omnibus  $\pm$  marginatis, cum aetate patentibus vel recurvis, 5—6 mm. longis; corolla 1·9 cm. longa, tubo albo, ca. 4 mm. longo, segmentis 3-seriatis, e supra medium inferne angustatis, obtusis vel emarginatis, dimidio inferiore albo, superiore purpureo rosea; filamenta gracillima, ca. 3-seriata, alba, antheris pollineque luteis; segmenta disci acuta; ovarium conice ad 0·75 mm. elevatum, lobis vix compressis; stylus subnullus; stigmata 6, gracillima lutea, ad 1·1 cm. longa.

Cape Province: Namaqualand; "Aggenys", between Springbok and Pofadder, *H. C. Kennedy* (NBG 339/65).

Fl. Mart. 1967.

This species differs from all the other species of **Conophytum** known to me in having the diameter of the bodies greatest a little above their base and least at their apex.

Mr. Kennedy's collection was made on Mr. C. Burger's farm, "Aggenys", and bears his name. "The plants were quite plentiful but in a very restricted area and in hard stony clay ground."

**Conophytum lacteum** L. Bol., sp. nov. (*Derenbergia-caespitosa-vestita*).—Plantae 2 visae, ad 6·5 cm. altae; vaginae persistentes brunneae vel demum atrae; folia supra lateraliterque visa linearia, prope apicem leviter angustata, obtusa vel subacuta, 3·5—6 cm. longa cum vagina ad 2·8 cm. longa, basi laminae 7—10 mm. lata diametroque, divergio ad 2 cm. longo; pedunculi 1·6—2 cm. longi, bene infra medium bracteati, bracteis membranaceis; receptaculum ad 3 mm. longum, ad 5 mm. diam.; calyx ad 1·1 cm. longus, tubo ad 5 mm. longo, segmentis 5, omnibus marginatis, acutis vel obtusis, glandulose

pubescentibus, 5—7 mm. longis, ad 2 mm. latis; corolla lactea, ad 2 cm. longa, tubo ad 6 mm. longo, segmentis ca. 3-seriatis, obtusis, ad 1·5 mm. latis; stamina ca. 6—8-seriata, filamentis superioribus aureis, antheris pollineque luteis; medium ovarii fere ad 1 mm. elevatum; stylus 2—3 mm. longus; stigmata 5, gracillima, ad 8 mm. longa.

Cape Province: Namaqualand; between Steinkopf and Port Nolloth, Kossies, *P. van Heerde*. Bolus Herb. 27954.

“Kossies is a flat-topped mountain or koppie which can be seen from the road to Port Nolloth. The collection was made in 1966 on the flat open ground north-west of Kossies, and flowered on my rockery in Apr. 1967.”

***Amphibolia gydouwensis*** (L. Bol.) L. Bol. comb. nov.

*Lampranthus gydouwensis* L. Bol. Journ. S.A. Bot. **29**: 13 (Jan. 1963).

***Lampranthus argenteus*** (L. Bol.) L. Bol. comb. nov.

*Mesemb. argenteum* L. Bol. Ann. Bol. Herb. **4**: 8 (1925).

***Lampranthus montaguensis*** (L. Bol.) L. Bol. comb. nov.

*Mesemb. montaguense* L. Bol. l.c., 9 (1925).

***Octopoma rupigenum*** (L. Bol.) L. Bol. comb. nov.

*Ruschia rupigena* L. Bol. Mesemb. **2**: 520 (1935).

***Sphalmanthus bijliae*** (N. E. Br.) L. Bol. comb. nov.

*Aridaria bijliae* N. E. Br.—Journ. Bot. **66**: 140 (1928).

*Nycteranthus bijliae* (N. E. Br.) Schwart.—Jacobsen's Handbook, p. 1313 (1961).

***Braunsia geminata*** (Haw.) L. Bol. comb. nov.—

*Mesemb. geminatum* Haw.—Misc. 92 (1803).

***Braunsia apiculata*** (Kensit) L. Bol. comb. nov.—

*Echinus apiculatus*—L. Bol. Fl. Pl. S. Afr. **VII**: 266 (1927).

*Memb. apiculatum* Kensit.—Trans. Roy. Soc. **I**: 154 (1909).

***Braunsia vanrensburgii*** (L. Bol.) L. Bol. comb. nov.—

*Echinus vanrensburgii* L. Bol. Mesemb **3**: 284, 288 (1954).

***Braunsia bina*** (N. E. Br.) Schwant. comb. nov.—Gartenwelt **32**: 644 (1928).—

*Mesemb. binum* N. E. Br.—Journ. Linn. Soc. Bot. **45**: 119 (1920).

***Stayneria neilii*** (L. Bol.) L. Bol. comb. nov.

*Ruschia neilii* L. Bol.—Mesemb. **2**: 433 (1934).

*Stayneria littlewoodii* L. Bol.—Journ. S.A. Bot. **27**: 48 (1961).

The first collection of this species was made by Mr. Neil of Bonnievale and was published in 1934 as ***Ruschia neilii***. This error had not been detected when the second excellent material was collected by Mr. Littlewood and proved to be a new genus.

***Ruschia drepanophylla*** (Schlecht. et Bgr.) L. Bol. comb. nov.—

*Mesemb. mallesoniae* L. Bol.,—Ann. Bol. Herb. **3**: 129 (1922).

*Ruschia mallesoniae* (L. Bol.) L. Bol., Journ. S.A. Bot. **29**: 16 (1963).

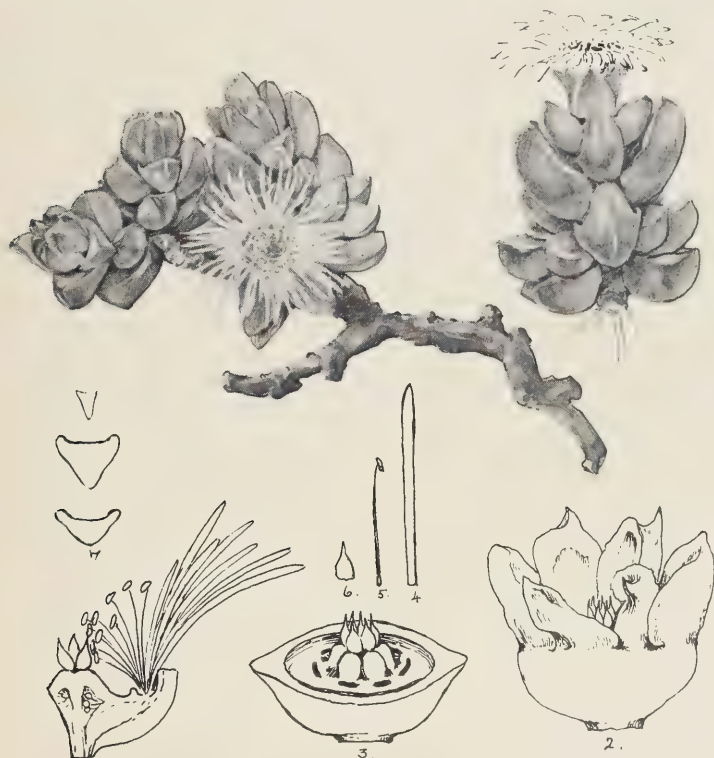
## CORRECTIONS

**Lithops marginata** Nel. "Lithops," Nel 113 (1947).

*Lithops dabneri* L. Bol., Journ. S.A. Bot. **31**: 237 (July 1965).

I am indebted to Dr. H. W. de Boer for this correction. He wrote: "Herewith I inform you that I got one plant of *Lithops dabneri* L. Bol. from Mr. H. Hall.

I have to tell you that this plant is quite identical with **L. marginata** Nel, of which species I have a population of about 50 plants. Though these 50 adult plants are somewhat varying (as all lithops species do) as well in color as in their markings on the top surface, the conformity of the 1 plant of *L. dabneri*



1. Longitudinal section of flower, sepals removed  $\times 3$ ; 2, Flower, petals and stamens removed  $\times 3$ ; gynoecium  $\times 3$ ; 4, petal  $\times 3$ ; 5 stamen  $\times 3$ ; 6 stigma—  $\times 3$ ; transverse section of leaf.

with *L. marginata* is so complete, that one cannot even say that *L. dabneri* is a local variety of *L. marginata*: they are the same."

The type-species of *L. marginata* was described without flowers and without the exact locality in South West Africa. Dr. de Boer gives no information on these points. His letter is dated "30.10.65". Nor does he mention the exact locality of "the population of about 50 plants". But his statement that the one plant of *L. dabneri* he saw could not be considered "a local variety" implies that they might have been derived from the type-locality.

The following 2 collections were sent to the National Botanic Gardens, Kirstenbosch, and were duly registered, except that the name of the collector was not correctly recorded. It appeared on the labels as "Pitten", and as both collections were new species they were published with a name that did not actually exist. The full name is Joost van Putten who lived near the coast at the approach to Lambert's Bay, his property being called Van Putten's Vlei. (This name appears in local maps of that area).

The corrected names of these species are:

**Cephalophyllum vanputtenii** L. Bol.—Mesemb. I: 120, 149 (1928).

**Lampranthus vanputtenii** (L. Bol.) N.E.Br.—Mesemb. II: 98 (1929).

A collection of *Lampranthus gracilipes* (L. Bol.) made by *E. Esterhuysen* in Oct. 1954 in Namaqualand, was on the Khamiesberg, near Garies (Pass to Leliefontein), and considerably adds to the limit of distribution already recorded in this Journal, Vol. 32: 223. It is among the most widely spread species that have been noted hitherto.

**Mesembryanthemum louiseae** (L. Bol.) L. Bol. nom. nov.—*Cryophytum planum* L. Bol. Mesemb. II: 15 (1928). *Mesembryanthemum stratum* L. Bol. Mesemb. III: 167 (1939) non N.E.Br.

*Note:* The type specimens of all new species described in this paper are in the Bolus Herbarium, University of Cape Town.

**Esterhuysenia** L. Bol. gen. nov.—Planta 1 visa, glabra, 21 cm. alta, 42 cm. diam.; radix reptans, ad 52 cm. longa, ad 7 mm. diam.; caulis apud basim 8 mm. diam., copiosissime ramosus ramulosusque, ramulis et ramis 0.5—4 mm. diam., internodiis saepius 2—10 mm., vel rarius ad 2 cm. longis; partes herbaceae in siccis minute tuberculatae; folia ascendentia vel patentia, apiculata, 6—10 mm. longa, 1—2 mm. diam.; flores solitarii diurni; pendunculi 2—4 mm. longi; receptaculum obconicum, 1.5 mm. longum, 4 mm. diam., vel 3 mm. longum, 5 mm. diam.; sepala 5, basi incrassata, apiculata, interiora marginata, 3—4 mm. longa, basi 1.5—2 mm. lata; petala 2-seriata, inferne leviter angustata, obtusa rosea, ad 8 mm. longa, ad 1.25 mm. lata; staminodia nulla visa; stamina ca. 4-seriata, ad 3 mm. longa; ovarii lobi dorsale complanati vel leviter compressi, ad 0.5 mm. elevati; stigmata 5, dimidio inferiore angustissime subulato, dimidio



superiore caudato, ca. ad 2 mm. longa; capsula infra obconica, saepius ad 3 mm. longa, ad 4 mm., expansa, ad 10 mm., diam., carinis crassis integris, inferne parallelis, superne late divergentibus, dimidium valvae attingentibus, alis tuberculisque nullis, alis tegentibus loculorum bene evolutis.

Species 1, *E. alpina*.

Cape Province: in dit. Worcester; Hex River Mountains, Milner Peak, East Side, on ledges, 5,500—6,000 ft., Dec. 1948, *E. Esterhuysen* 14817.

This genus is closely allied to *Lampranthus* and *Ruschia* but the capsule lacks the wings of the former and the tubercle of the latter.

The description was made from dried material, but the following notes were taken from a more recent collection of the same species in the living state.

Plantae ad 33 cm. altae; partes herbaceae leves vel in siccis minute tuberculatae; folia erecta vel ascendunt vel fere patentia, vel interdum subfalcata, supra plana linearia, prope apicem leviter angustata, lateribus subconvexulis, dorso rotundo vel obscure carinata, carina ad lineam reducta, apiculata, subglauca viridia vel senectissima rubra, 8—10 mm. longa cum vagina ad 1.5 mm. longa, medio 1.5—2.5 mm. lata, medio 1.5—2.5 mm. lata diametroque; flores solitarii diurni, saepius 1.7 cm. diam.; pedunculi 6—9 mm. longi, prope medium vel parum supra bracteati, bracteis 3—5 mm. longis; receptaculum obconicum, 3—4 mm. longum, 4—5 mm. diam.; sepala 5, acuta vel subacuta, omnia  $\pm$  marginata, 2.5—3 mm. longa, basi 1.5—2 mm. lata vel 4—5 mm. longa, basi 2—3 mm. lata; petala ca. 3-seriata, interiora pauca, inferne e prope medium leviter angustata, obtusa, roseo purpurea, ad 8 mm. longa, ad 1.25 mm. lata; staminodia gracillima, prope apicem recurva, rosea, stamina excedunt; filamenta ca. 4-seriata, rosea, interiora prope basin papillata, antheris pollineque luteis; discus conspicuus crenulatus; ovarium versus medium leviter elevatum; stigmata 5, sat gracilia, inferne papillata, superne caudata, ca. 2.5 mm. longa.

Cape Province: in dit. Worcester; Fonteintjiesberg "Growing from crevices and depressions in massive rock formations on plateau leading to beacon, ca. 6,000 ft. Small compact low shrubs" Nov. 1966 *E. Esterhuysen* 31649.

CORRECTION

Line 1, p 234, vol 32 (1966) for *carpiana* read *carpii*.



## NOTES ON THE GENUS DELOSPERMA (MESEMBRIEAE)

M. LAVIS

**Delosperma adelaidense** Lavis sp. nov. (*Planifolia-Pubescentia*).—Rami 2 visi, 3—5 cm. longi, ad 3 cm. diam., internodiis ad 1.1 cm. longis, ad 2 mm. diam.; partes herbaceae laete virides; folia ascendentia vel patentia vel e medio recurva, supra plana vel leviter concava, linearia obtusa, vel oblonge obovata, interdum leviter dimidiata, dorso subconvexo, minute punctata, punctis setiferis, setis ascendentibus vel patentibus vel decurvis, quam punctis longioribus, ad 1.6 cm. longa, explanata 4—7 mm. lata; flores 3-nati; pedunculi teretes hispidi, 2—5 mm. longi; receptaculum obconicum vel subglobosum vel fere semiglobosum, setiferum, setis fere ad 1 mm. longis, 4 mm. longum, ad 5 mm. diam., sepala 5, exteriora subobtusa, 8 mm. longa, basi 2.5—3 mm. lata, interiora marginata acuta, 3—5 mm. longa, basi 3—4 mm. lata; petala ca. 30, 2-seriata, parum inaequilonga, e parum supra medium subcuneate angustata, purpureo rosea, ad 7 mm. longa, ad 1 mm. lata; staminodia stamina leviter excedentia, 3 mm. longa; filamenta 3-seriata, alba, fere epapillata, antheris pollineque albidis; glandulae crenulatae, fere contiguae; ovarii lobi obtusi, leviter compressi, glandulas attingentes; stigmata angustissime subulata, inconspicue papillata, 1.5 mm. longa, cauda subnulla.

Cape Province: in dit. Fort Beaufort; Adelaide, Apr. 1931, *E. E. Galpin*. NBG 834/31.

Fl. Jan. 1932.

**Delosperma affine** Lavis sp. nov. (*Planifolia-Glabra*).—Rami culti 7 visi, 11.5—29 cm. longi, internodiis 1.9—4 cm. longis, 2—3 mm. diam.; ramuli laterales 3.6—13.5 cm. longi, ultimi florentes interdum congesti, ca. 1.5—3 cm. longi; partes herbaceae glabrae levissimae politaeque, laete, vel interdum subglaucae, virides; folia erecta vel ascendentia vel patentia vel e medio recurva supra, manu explanata, lineare lanceolata, acuminata, interdum apiculata, vel breviora obtusa vel subobtusa, 2—5 cm. longa, 7—11 mm. lata, ca. 4 mm. diam.; pedunculi teretes, 5—7 mm., fructiferi ad 9 mm., longi; receptaculum globose obconicum, 4 mm. longum, 5—6 mm. diam.; sepala 5, exteriora linearia, acuta

vel subobtusata, 8—10 mm. longa, basi 2 mm. lata, interiora acuta vel acuminata, late marginata, ad 3 mm. longa, basi ca. ad 2·5 mm. lata; petala 2-seriata (interiora pauca), e bene supra medium inferne conspicue angustata, obtusa alba, ad 9 mm. longa, ad 1·5 mm. lata; staminodia superne recurva, ad 7·5 mm. longa; stamina ca. 4-seriata, intima parum supra medium papillata, 4—5 mm. longa, antheris pollineque luteis; glandulae crenulatae approximatae; ovarii lobi obtusi, vix compressi, glandulas fere attingentes, ad 1—5 mm. elevati.; stigmata inferne subulata, inconspicue papillata, 2 mm. longa cum cauda 1 mm. longa vel parum ultra.

Locus ignotus; fl. National Botanical Gardens, Kirstenbosch, Apr. 1921 Bolus Herbarium 16966.

**Delosperma leightoniae** Lavis sp. nov. (*Angustifolia*).—Planta 1 visa, erecta glabra robusta, ad 10 cm. alta, caule lignoso brevissimo, ca. 1·5 cm. diam., fere e basi 2-ramoso, ramis primariis fere ad 1·4 cm. diam.; ramuli graciles virgati, 10·5—20 cm. longi, basi ad 4 mm., deinde 2·5 mm. vel supra medium 1 mm. diam., internodiis 7—49 mm. longis; folia saepius erecta vel ascendunt, supra lateraliterque visa acuminata vel acuta, dorso obscure carinata, viridia vel glauca viridia, in siccis papillatis, papillis albis; pedunculi 1·7—2·8 cm., vel culti ad 4·5 cm., longi; receptaculum obconicum, 3·5 mm. longum, 6 mm. diam., in pedunculum gradatim abeunt; sepala 5, acuminata, exteriora 7—9 mm., vel in flore altero culta ad 1·2 cm., longa, basi 3·5 mm. lata, interiora 5—6 mm. longa, basi 2·5—3 mm. lata; petala 2—3-seriata, interiora pauca, prope basim tantum angustata, obtusa, in siccis pallide rosea, 7—9 mm. longa, 0·5—1 mm. lata; staminodia nulla; stamina 3-seriata, glabra pallida, 4—6 mm. longa; glandulae conspicuae subapproximatae; ovarii lobi abrupte ad 1 mm. elevati, glandulas non attingentes; stigmata 5, anguste subulata, ad apicem verum conspicue papillata; capsula infra obconica, inconspicue obtuse 5-angulata, 4 mm. longa, 7 mm., expansa, ad 1·2 cm., diam., valvis expansis, valde recurvis, supra ca. per 2 mm. elevatis; semina muricata, saturate brunnea, ca. 0·5 mm. diam.

Cape Province: in dit. Kingwilliam's Town; Thomas River, Jan. 1947, F. M. Leighton. Bolus Herbarium 27830.

Fl. hort. L. Bolus, Nov. 1948.

**Delosperma minimum** Lavis sp. nov. (*Carinata*).—Plantae 9 visae, primum dense compactae, 4—5 cm. diam., caule 4—10 mm. diam., deinde sat laxae ramosae ramulosaeque, ramis pallidis, ad 8—5 cm. longis, internodiis subpallidis, 5—15 mm. longis, ad 2 mm. diam.; folia variabilia, ascendunt vel patentia, supra ovata obtusa vel subacuta, 4—8 mm. longa, ad 4 mm. lata diametroque, vel linearia acuta vel lateraliter visa obtusa, saepius 10—24 mm. longa, 5 mm. lata diametroque; flores fere sessiles, 2·6—3·2 cm. diam.; bractae

2·5—7·5 mm. longae; receptaculum semiglobosum, ad 2 mm. longum, ad 4 mm. diam.; sepala 6, 3—5 mm. longa, saepius acuta, omnia marginata; petala 3—4-seriata, inferne leviter angustata, obtusa vel subtruncata, eburnea vel pallide rosea, 5—14 mm. longa, ad 1 mm. lata; staminodia subnulla; filamenta ad 5-seriata, intima apud basim dense papillata; ovarii lobi ca. ad 0·75 mm. elevati.

Cape Province: in dit. Albany; Makana's Kop, prope Grahamstown. Feb. 1952, *G. V. Britten*. Albany Museum Herb. 37.

Fl. hort. L. Bolus, Feb.-Apr. 1953-1955.

***Delosperma angustipetalum*** Lavis sp. nov. (*Carinata*).—Planta caespitosa, inter minima in genere, ad 12 cm. alta, ad 5 cm. diam.; radix ad 5 mm. diam.; caulis 5 mm. diam., internodiis inclusis; folia ascendentia vel fere erecta, ad 2·7 cm., vel saepissime 1—1·5 cm., longa, carina obtusa, lateribus leviter convexis, supra leviter concava; flores sessiles, 2·5—2·8 cm. diam.; receptaculum hemisphaericum, 4·5 mm. longum, 9 mm. diam.; sepala 6, ca. 5—7 mm. longa, basi ad 6 mm. lata; petala 4—5-seriata, laxa linearia obtusa alba, ad 1·2 cm. longa, ad 0·5 mm. lata; staminodia nulla; filamenta 5-seriata, glabra; glandulae inconspicuae; ovarii lobi erecti obtusi, apud apicem rotundi, ad 1 mm. elevati; stigmata 6, grosse subulata, cum cauda fere 1 mm., 2 mm. longa.

Cape Province: in dit. Albany; *N. S. Pillans*. NBG 388/16.

Fl. Jan. 1920. Described from 2 dried specimens and a coloured plate depicting the type material, with 9 enlarged pen-sketches of all main parts of a flower.

***Delosperma pergamentaceum*** L. Bol. **var roseum** Lavis var. nov.—(*Compressilatera*)—a forma typica planta omnino pallidissime roseo suffusa; foliis omnibus saepius minoribus; floribus 3—5 cm. diam.; sepalis 5—13 mm. longis; petalis pallide roseis, differt.

Cape Province: Namaqualand; Richtersveld, 8 miles east of Koeskop, gravel soil, Oct. 1938. *J. P. Roux* 519.

*Note:* The sections *Carinata* and *Compressilatera* may be distinguished from each other as follows: in the former the sepals 6, stigmas 6, subulate, much shorter than the stamens. In the latter sepals 5, stigmas 5, filiform, equalling or exceeding the stamens.

***Delosperma*** Lavis sect. nov.—Papillosum, papillis rigide setosis, setis persistentibus vel demum deciduis et papillis induratis albisque.

LECTOTYPE. ***Delosperma echinatum*** (Ait.) Schwant. comb. nov, *Möller's* Deutsch. Gärtner Zeit. XLII, 258, 1927.

This section consists of a single species and differs from all the rest of the genus in having a rigid seta on the papillae, giving the vegetative parts the bristly appearance which suggested the specific name. These bristles persist even on



some of the oldest parts of the plant, until with age or friction they disappear, leaving the papillae indurated and white. The flowers are solitary and the petals are white or vary from cream to deep-yellow.

It was figured in 1799 by Redouté (Plant. Grasst 24) and by Salm-Dyck in 1842 (53. Fig. 2). The latter remarks that it was frequently cultivated.

The following collections of this section represented in the Bolus Herbarium, made from 1911-1934, and chiefly, from the Divisions of Albany, Uitenhage and Port Elizabeth, rarely extending to the Humansdorp and George Divisions, arranged in chronological order . . . Mrs. T. V. Paterson 4, N. S. Pillans (NBG 425/16), R. A. Dyer 1114, G. Britten "C.", J. Luckhoff, P. Ross Frames, L. Bolus and H. G. Fourcade.

*Note:* **D. leightoniae** and **D. minimum** were described from notes and observations made by L. Bolus; **D. adalaidense** and **D. pergamentaceum** var. **roseum** from drawings by B. O. Carter and M. Walgate respectively, and **D. affine** and **D. angustipetalum** from 2 excellent drawings by M. M. Page.

#### CORRECTION

**Delosperma lebomboense** Lavis sp. nov. et comb. nov. (*Planifolia-Glabra*).—*D. tradescantioides* (Bgr.) L. Bol. var. *lebomboense* L. Bol. in Mesemb. II: 382 (1933).—Hac species a *D. tradescantioides* foliis saepissime ovate lanceolatis, acutis vel acuminatis, pallide luteo viridibus; receptaculo crateriforme; petalis acutis vel acuminatis, stramineis; filamentis omnibus epapillatis; ovarii lobis stellate patentibus et glandulas attingentibus, praecipue differt.

The following collections are represented in the Bolus Herbarium:

Zululand: Lembobo Flats, Sept. 1932, *Galpin*. NBG 2214/32. Typus.

TYPE. MKUZI, "in karroid scrub at the side of the Pongola River, immediately above the Poort in the Lebombo Mts. through which it runs. Fls. yellow. Only one large clump seen associated with **Azima tetracantha**." Sept. 1932. *Flora Sargent*. Flats across the Pongola River, at Ottobotini, Jul. 1936, *I. C. Verdoorn* 1685. "Ingwavuma district, Shemula's Poort, prostrate, succulent herb in dry Treeveld, common, staminodes white, altitude 200 ft.", Jul. 1954, *C. J. Ward* 2359. Ubombo; Makalini Flats, "Fls. white," June 1964 *R. G. Strey* 5310 b. Natal: Louwsberg; "on the farm Louwskloof, between sandstone, common," Jan. 1950 *L. C. C. Liebenberg* S.U.G. 12385. Pongola, Meersetting, "in open grassveld, light sandy soil, common." Jan. 1950. *L. C. C. Liebenberg* S.U.G. 12388. Swaziland: Nov. 1960. *R. H. Compton*. Ngwavuma Poort, Sept. 1962, *R. D. Bayliss* 674.

*Note:* The type specimens of all new species described in this paper are in the Bolus Herbarium, University of Cape Town.

## STUDIES IN THE XYLARIACEAE

### II. ROSELLINIA AND THE PRIMO CINEREA SECTION OF HYPOXYLON

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The genus *Rosellinia* DN has been the subject of considerable misinterpretation since its inception in 1884 by De Notaris. Based on *R. aquila*, it was subsequently made to include a large number of globose pyrenomycetes, some of which had a true stroma as in the type species, and some which merely consisted of one or a few perithecia under a thin hyphal covering. The presence of the entostroma enclosing the perithecium was not truly recognized in the former until Miller's review in 1928 (pp. 191, 326), and even he did not apparently realize that there was no essential difference between many species of *Rosellinia* and the members of his sub-section Primocinerea of *Hypoxylon* (1961, p. 57).

Saccardo (1882) divided the genus into 10 sections:

- |                     |   |
|---------------------|---|
| (1) Eurosellinia    | Perithecia large, glabrous, with basal subiculum.                         |
| (2) Calomastia      | Perithecia fairly large, glabrous, subiculum absent.                      |
| (3) Tassiella       | Perithecia fairly large, but without setae.                               |
| (4) Amphisphaerella | Perithecia sunken basally into the substrate as in <i>Anthostomella</i> . |
| (5) Coniomela       | Perithecia small, glabrous, often densely gregarious.                     |
| (6) Coniochaeta     | Perithecia small, setose, often gregarious.                               |
| (7) Cucurbitula     | Perithecia caespitose and erumpent.                                       |
| (8) Lichenicolae    | Inhabiting lichens.   |
| (9) Sphaeropyxis    | Perithecia shortly stipitate, spores globose.                             |
| (10) Desciscentes   | Miscellaneous and ill defined.  |

The lack of uniformity of the characters selected makes the division unworkable. Kirschstein (1933, p. 403) later recognized that these subgroups belonged to different families of the Sphaeriales, and placed them in four families: Trichosphaeriaceae, Melanommaceae, Amphisphaeriaceae, and Cucurbitariaceae. Three subgroups, *Coniomela*, *Amphisphaerella*, and *Cucurbitula*, were given generic rank, and another subgroup, *Coniochaeta*, was merged with *Helminthosphaeria* (Trichosphaeriaceae). *Coniomela* and *Rosellinia* (emended) were placed in the Melanommaceae.

While the other genera were no doubt correctly placed, there was no demon-

trable affinity shown between *Rosellinia* as emended and the other Melanomma-ceae. There is a definite outer crust, which is usually carbonaceous, protecting the membranous perithecium and the perithecia are often separated from the substrate by a corky layer beneath (Plate I, 1). The spores are one celled while spores of the Melanomma-ceae typically have one or more septae.

The *Primocinerea* subsection of *Hypoxylon*. Miller (1961) established two subsections in his section Papillata, based primarily on the papillate or conic nature of the ostioles: one (*Primocinerea*), including species which remained grey or dark at maturity and did not develop pigment, and the other (*Papillata*) including those which were coloured at least during development. The present writer has found this difference to be augmented in that the germ slit usually occurs on the flat or concave side of those spores which are inequilateral in the species of the non-coloured group, while the reverse is true of the coloured section. On the other hand special significance should be attached to the *absence* rather than presence of papillate ostioles since the latter occur in the majority of the Xylariaceae as a whole, and one section (*Euhypoxylon*) out of the four sections of the genus *Hypoxylon* originally established by Miller (1961) is rightly distinguished by its umbilicate nature. Logically, similar stress ought to be placed on the *absence* of coloured pigment in the outer stroma, since a pigment can be demonstrated in all species of *Hypoxylon* but in the *Primocinerea* group. Thus there appears to be good reason to dissociate Miller's two subsections.

Furthermore the affinity of the subsection *Primocinerea* with *Rosellinia* seems clear for the following reasons:

- (1) The stromata vary from uni- to multiperitheciate, often within the same sample. This feature has been admitted several times in the literature but has not been recognized in classification. Three other species groups of *Hypoxylon* (*Papillata*, *Annulata*, *Euhypoxylon*) share this feature, but its general occurrence in the rest of the Xylariaceae is limited. (Plate I: 3-7).
- (2) The structure of the stroma is relatively uniform. The ectostroma forms a soft superficial veneer while the entostroma is divided into a prominent black carbonaceous shield and a basal corky layer that is invariably lighter in colour, although in many cases feebly developed. (Plate I: 2).
- (3) The ascial plugs are of the cubicular-rectangular variety, while in the other groups of *Hypoxylon* they are discoid or flattened. (Plate II: 1-5).
- (4) The spores, if inequilateral, usually bear the germ slit on the least convex surface. (Plate II: 1).

- (5) The hyaline sheath on the spore is conspicuous in many cases, while it is never so in other groups of *Hypoxylon*.
- (6) The imperfect stages known for a large representative sample of the species conform to the genus *Nodulisporium* which was described in the previous paper. This furnishes important additional evidence that the group is a natural one. See Plate II: 6 and 7.

In addition the following species from other groups are considered to belong here for the same reasons:

Species	Group or Genus where formerly placed
<i>Hypoxylon chrysoconium</i> Berk. & Br. syn. <i>Rosellinia subiculata</i> (Schw.) Sacc.	<i>Hypoxylon</i> subsection Papillata
<i>Hypoxylon morgani</i> E. & E.	<i>Hypoxylon</i> subsection Papillata
<i>Penzigia bermudensis</i> Miller	<i>Penzigia</i>
<i>Penzigia cantareirensis</i> (Henn.) Mill.	<i>Penzigia</i>
<i>Penzigia citrina</i> (Shear) Mill.	<i>Penzigia</i>
<i>Penzigia discolor</i> (Berk. & Br.) Mill.	<i>Penzigia</i>

In *Hypoxylon chrysoconium* the yellow subiculum was mistaken by Miller for part of the stroma. *H. morgani* does not have a carbonaceous exterior and is pale in colour but, however, lacks an extractable pigment. In the four species of *Penzigia*, there is a white or brightly coloured basal tissue that is more prominent than in most members of *Primocinerea* but they are classified with them because the number of the perithecia per stroma are few, and the perithecia are evident in outline. They are somewhat intermediate with *Kretzschmaria* but are excluded because in typical members of *Kretzschmaria* some part of the stroma is usually sterile, comprising either a stipe or umbonate apex, and the perithecia are very rarely evident in outline.

For this same reason, one species, *H. cyclopicum* Speg. is excluded from the *Primocinerea* group where it was placed by Miller. It has a clear umbonate apex and the writer believes that the previous name *Kretzschmaria aggregata* (W. & C.) Sacc. is appropriate. Another species, *H. udum* Pers. ex Fr. should belong to the genus *Anthostomella* because the stroma is permanently immersed in the substrate. It is accordingly renamed now as *A. uda* (Pers. ex Fr.) Martin.

The writer proposes a new section of *Hypoxylon* to cover the species associated here. Sydow's genus *Entoleuca* (1922) is etymologically correct and thus considered the most appropriate, though it was only originally applied to one species, *E. callimorpha* Syd. [*Hypoxylon mammatum* (Wahl) Miller]. Miller's original section Papillata now comprises only the pigmented species therein, with simple papillate ostioles.

Key to the main species of the Section *Entoleuca* (Syd.) Martin sect. nov. and to other genera formerly confused with *Rosellinia*:

1.	Perithecia naked, not enclosed in a stroma though sometimes covered with a mycelial felt .. .. .	2
1'	Perithecia enclosed in a definite crustose stroma ( <i>Rosellinia</i> & <i>Hypoxylon</i> ) .. .. .	16
2.	Perithecia basally immersed, only vertices projecting; spores $8.0-11.0 \times 17.5-19.0\mu^*$ <i>Amphisphaerella amphisphaerioides</i> (Sacc. & Speg.) Kirschst. syn. <i>Rosellinia amphisphaerioides</i> Sacc. & Speg.	
2'	Perithecia densely aggregated, erumpent; spores $4.5 \times 6.5\mu$ <i>Cucurbitula myricaria</i> Fuckel syn. <i>Rosellinia myricaria</i> (Fuckel) Sacc.	
2''	Perithecia superficial .. .. .	3
3.	Perithecia glabrous ( <i>Coniomela</i> ) .. .. .	4
3'	Perithecia setose ( <i>Hepminthosphaeria</i> ( <i>Coniochaeta</i> )) .. .. .	13
4.	Perithecia seated on sparse basal subiculum .. .. .	5
4'	Perithecia without subiculum .. .. .	6
5.	Subiculum fawn grey with pronounced sandy appearance; spores $6.5 \times 10.0\mu$ <i>Coniomela substromatica</i> (E. & E.) Kirschst. syn. <i>Rosellinia substromatica</i> E. & E.	
5'	Subiculum grey black, closely appressed and smooth; spores $7.0 \times 11.5\mu$ <i>Coniomela parasitica</i> (E. & E.) Kirschst. syn. <i>Rosellinia parasitica</i> E. & E.	
6 (4)	Spores with curved beaks, $6.5 \times 14.0\mu$ <i>Coniomela rhyncospora</i> (Hark.) Kirschst. syn. <i>Rosellinia rhyncospora</i> Harkness	
7.	Spores appendiculate, $10.5 \times 15.5\mu$ <i>Coniomela compressa</i> (E. & D.) Kirschst. syn. <i>Rosellinia compressa</i> Ellis	
7'	Spores not appendiculate .. .. .	8
8.	Spores with fine reticulate wall sculpturing, $10.5 \times 18.0\mu$ <i>Coniomela fibriseda</i> (E. & E.) Kirschst. syn. <i>Rosellinia fibriseda</i> E. & E.	
8'	Spore wall smooth .. .. .	9
9.	Ostioles very prominent, often beak-shaped, asci thick walled, spores $21.0 \times 36.6\mu$ <i>Coniomela ostiolata</i> (E. & E.) Kirschst. syn. <i>Rosellinia ostiolata</i> E. & E.	
9'	Ostiole clearly though minutely papillate .. .. .	10
9''	Ostiole not clearly visible, at stroma level .. .. .	11
10.	Spores $5.0 \times 14.5\mu$ <i>Coniomela callimorphoides</i> (Rehm) Kirschst. syn. <i>Rosellinia callimorphoides</i> Rehm	
10'	Spores $9.0-10.0 \times 19.0-19.5\mu$ <i>Coniomela dispersella</i> (Nyl.) Kirschst. syn. <i>Rosellinia dispersella</i> (Nyl.) Karst.	
11 (9)	Perithecia reddish brown, spores $7.5 \times 10.0\mu$ <i>Coniomela rhodomela</i> (Schw.) Kirschst. syn. <i>Rosellinia rhodomela</i> (Schw.) E. & E.	
11'	Perithecia black .. .. .	12
12.	Perithecia globose, $100-200$ diam., on pine; spores $4.0 \times 7.5\mu$ <i>Coniomela pinicola</i> (E. & E.) Kirschst. <i>Rosellinia pinicola</i> E. & E. (ined.?)	
12'	Perithecia globose to ovate, $100-200\mu$ , on various hosts; spores variable $5.5-9.0 \times 9.0-14.5\mu$ <i>Coniomela millegrana</i> (Schw.) Kirschst. syn. <i>Anthostoma lambottiana</i> Faut. <i>Rosellinia millegrana</i> (Schw.) Sacc.	

\* Figures expressed to the first place of decimals represent averages of a set of measurements; integers only, the mere range of dimension.

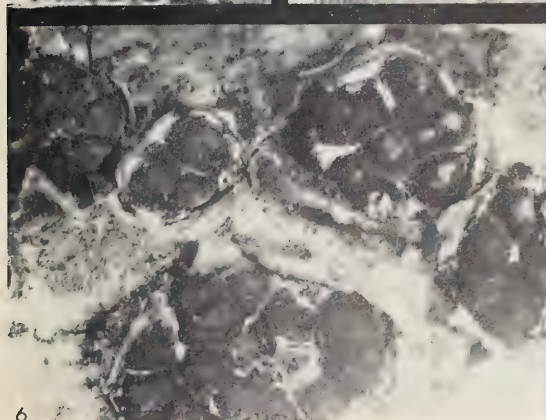
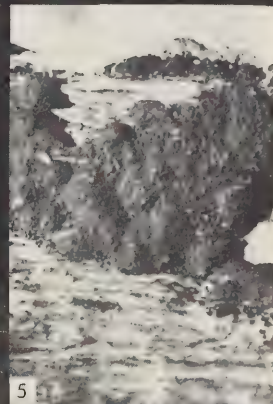
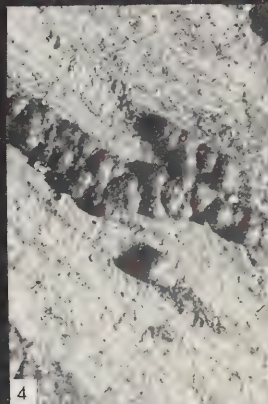


- R. bigeloviae* E. & E.  
*R. caespitosa* E. & E.  
*R. librincola* Karst.  
*R. ovalis* (Ell.) Sacc.  
*R. pulveracea* (Ehr.) Fckl.  
*R. rimincola* Rehm  
*R. rosarum* Nissl.  
*R. sarothamni* Schrot.  
*R. stigma* E. & E. (ined.?)  
*R. subcorticalis* Fckl.
- 13 (3) Perithecia seated on a sparse brown subiculum, irregular in distribution;  
 spores  $5.0 \times 8.5\mu$   
*Helminthosphaeria* (Coniochaeta) *muriculata* (E. & E.) Kirschst.  
*Rosellinia muriculata* E. & E.
13. Subiculum absent .. .. . 14
14. Shape of stroma ovoid, with rather wide truncate ostiole bearing a  
 characteristic fringes of setose hyphae; spores  $10.0 \times 14.5\mu$   
*Helminthosphaeria* (Coniochaeta) *niesslii* (Awd.) Kirschst.  
 syn. *Rosellinia niesslii* Auerswald
- 14' Setae basally attached or covering entire ascocarp; ostioles indistinct  
 and not truncate .. .. . 15
15. Spores oval,  $5.0 \times 7.0\mu$ ; 1-celled  
*Helminthosphaeria* (Coniochaeta) *velutina* (Fckl.) Kirschst.  
 syn. *Rosellinia velutina* Fckl.  
*R. ebulii* Rehm  
*R. hystrix* E. & E.  
*R. kellermanii* E. & E.
- 15' Spores variable,  $6.0-9.5 \times 10.0-15.5\mu$ ; 1-celled.  
*Helminthosphaeria* (Coniochaeta) *lignaria* (Grev.) Kirschst.  
 syn. *Rosellinia lignaria* (Grev.) Fckl.  
*R. abietina* Fuckel  
*R. arctaspora* Cke. & Ellis  
*R. ambigua* Sacc.  
*R. malacotricha* Niessl  
*R. sordaria* (Fr.) Rehm  
*R. xylariaespora* Cke. & Ellis
- 15'' Spores elliptic; 2-celled,  $7.5-8.0 \times 17.5-19.0\mu$   
*Helminthosphaeria* (Coniochaeta) *clavariae* (Tul.) Fckl.  
 syn. *Rosellinia clavariae* Desm.
- 16 (1) Subiculum absent .. .. . 17
- 16' Subiculum present .. .. . 75
17. Perithecial outlines hemispheric, ovoid or globose, or rarely with conic  
 vertices on globose bases .. .. . 21
- 17' Perithecial outlines sharply conic in outline, sometimes compressed .. 18
18. Stromata multiperitheciate, pulvinate, spores  $9.3 \times 25.0\mu$   
*Hypoxylon cerebrinum* (Fée) Cke.
- 18' Stromata mainly uniperitheciate .. .. . 19
19. Stromata basally immersed in the substrate; spores elliptic, inequilateral  
 convex,  $13.5 \times 38.0\mu$   
*Hypoxylon poliosum* (E. & E.) Martin  
 syn. *Rosellinia poliosa* E. & E.
- 19' Stromata superficial, spores crescentic .. .. . 20
20. Spores  $6.5-11.0 \times 30.0-34.5\mu$   
*Hypoxylon bresadolae* (Theiss.) Martin  
 syn. *Rosellinia bresadolae* Theiss.
- 20' Spores  $10.0 \times 50.5\mu$   
*Hypoxylon lamprostomum* (Syd.) Martin  
 syn. *Rosellinia lamprostoma* Syd.

21 (17)	Outer layer scabrous or plainly verrucose at maturity .. .. .	22
21'	Outer layer smooth or minutely verrucose at maturity, though sometimes white and scaly when young; continuous, or worn off at random..	32
22.	On leaves of palm; stromata containing one or a few perithecia and distinctly verrucose; spores $8.0 \times 19.5\mu$	
	<i>Hypoxylon folicola</i> Miller	
22'	On dead stems .. .. .	23
23.	Stromata mainly uniperitheciate .. .. .	24
23'	Stromata mainly multiperitheciate .. .. .	25
24.	Stromata globose, $1500-1880\mu$ diam. aggregated; spores $4.5 \times 10.5\mu$	
	<i>Hypoxylon megalocarpum</i> (Plow.) Martin	
	syn. <i>Rosellinia megalocarpa</i> (Plow.) Sacc.	
24'	Stromata ovoid, $1500-200\mu$ diam., not aggregated; spores $13.5 \times 34.0\mu$	
	<i>Hypoxylon tassianum</i> (C & DN) Martin	
	syn. <i>Rosellinia tassiana</i> C & DN.	
25 (23)	Initial layer dull yellow, later brown, conspicuous; ostioles truncate; spores $12.0-12.5 \times 24.5-29.5\mu$	
	<i>Hypoxylon quisquiliarum</i> Mont.	
25'	Initial layer otherwise coloured, ostioles not truncate .. .. .	26
26.	Spores over $30\mu$ long .. .. .	31
26'	Spores under $30\mu$ .. .. .	27
27.	Stromata erumpent, usually gregarious, $1-5$ peritheciate; spores $12.0 \times 24.0\mu$	
	<i>Hypoxylon rosellinioides</i> Henn.	
27'	Stromata superficial .. .. .	28
28.	Germ slits spiral .. .. .	29
28'	Germ slits straight or slightly undulate .. .. .	30
29.	Stromata aplanate, bearing gregarious perithecia evident in outline; basal tissues white; spores $6.5 \times 16.5\mu$	
	<i>Hypoxylon entoleucum</i> Martin nov. sp.	
29'	Stromata pulvinate, perithecia vaguely evident or immersed, basal tissue white, spores $9.5 \times 18.0\mu$	
	<i>Hypoxylon cadigensis</i> Yates	
30 (28)	Stromata globose to pulvinate; spores $6.5 \times 11.0\mu$ ; basal tissue saffron	
	<i>Hypoxylon discolor</i> B. & Br.	
	syn. <i>Penzigia discolor</i> (B. & Br.) Mill.	
30'	Stromata aplanopulvinate; spores $7.5-8.5 \times 26.0-28.0\mu$ ; basal tissue dull white to cream	
	<i>Hypoxylon cantareirens</i> Henn.	
	syn. <i>Penzigia cantareirens</i> (Henn.) Miller	
31 (26)	Stromata semiglobose or depressed, $2-4$ cm in diam.; spores $15-18 \times 45-60\mu$	
	<i>Hypoxylon nucigenum</i> Henn.	
31'	Stromata globose with areolate-tuberculate surface; $1-3$ cm in diam., spores $14-21 \times 50-60\mu$	
	<i>Hypoxylon fragaria</i> Ces.	
32 (21)	Stromata erumpent or superficial by attrition of substrate and with base still immersed .. .. .	33
32'	Stromata superficial or apparently so .. .. .	42

## PLATE I.

1. *Coniomela millegrana*; gregarious perithecia ( $\times 2.8$ ).
2. *Hypoxylon mastoideum* (*Rosellinia mammoidea*); Young stromata with scabrous ectostroma and white conidial layer ( $\times 2.8$ ).
3. *Hypoxylon serpens*; uniperitheciate stromata ( $\times 2.8$ ).
4. *Hypoxylon serpens*; uniperitheciate and multiperitheciate stromata ( $\times 2.8$ ).
5. *Hypoxylon serpens*; multiperitheciate stromata ( $\times 2.8$ ).
6. *Hypoxylon mammatum*; pulvinate stromata with evident perithecia and remains of white ectostroma ( $\times 3$ ).
7. *Hypoxylon mammatum*; effuse stromata with perithecial submersion ( $\times 3$ ).



33. Uniperitheciate stromata common; basal tissue slight . . . . . 34  
 33' Uniperitheciate stromata rare; basal tissue well developed, dull or bright coloured . . . . . 37  
 34. Substrate splits to form stellate lobes around the base of the stroma; stromata mainly uniperitheciate; spores  $6.0-6.5 \times 12.0\mu$ ; on monocotyledons  
     *Hypoxylon geasteroides* (E. & E.) Martin  
     syn. *Rosellinia geasteroides* E. & E.  
     *R. bambusae* Henn.  
     *Anthostomella mirabilis* (B. & Br.) v. Hoehn  
 34' Substrate worn off at random, stroma clearly exposed . . . . . 35  
 35. Upper surface of the stroma shiny, vertices of the perithecia usually conic, sometimes with a circular indentation corresponding to the removal of the outer layer; on dicotyledonous hosts; spores  $5.0 \times 10.5\mu$   
     *Hypoxylon ravenelii* Rehm  
     syn. *Rosellinia formosa* Penz. & Sacc.  
 35' Upper surface of the stroma dull; perithecial vertices ovoid or hemispheric without indentation . . . . . 36  
 36. On monocotyledonous hosts and predominantly uniperitheciate; spores  $6.5 \times 17.0 \times 18.5\mu$   
     *Hypoxylon sublimbatum* (D. & M.) Martin  
     syn. *Rosellinia sublimbata* (D. & M.) Pass.  
     *R. cocoes* Henn.  
     *Anthostomella arengae* (Racib.) Rehm  
 36' On dicotyledonous hosts and predominantly with more than one perithecium per stroma; stroma basally immersed only; spores  $7.0-8.5 \times 14.5-16.5\mu$   
     *Hypoxylon confluens* (Tode ex Fr.) West  
 37 (33) Spores inequilateral, with spiral germ slits,  $7.5 \times 21.0\mu$ ; stromata globose to hemispheric, constricted below  
     *Hypoxylon conostomum* Mont.  
 37' Spores equilateral, germ slits straight . . . . . 38  
 38. Ostioles papillate, stroma evenly attached . . . . . 39  
 38' Ostioles raised, poroid, spores  $16-24 \times 30-40\mu$ ; stroma constricted at the base, semiglobose to urceolate  
     *Hypoxylon megalosporum* Speg.  
 39. Stroma pulvinate or aplanopulvinate, perithecia clearly distinct, one to many per stroma; ostioles papillate to spout-shaped; spores elliptic to cylindric,  $8.0-11.0 \times 18.0-26.5\mu$   
     *Hypoxylon mammatum* (Wahl.) Miller  
 39' Stroma subglobose to pulvinate, perithecia immersed, one to few per stroma, ostioles minutely papillate to indistinct or umbilicate . . . . . 40  
 40. Interior of stroma tinted yellow or yellow-orange; ostioles indistinct or poroid, sometimes with conspicuous periphysate mouths; spores cylindric to elliptic,  $3.5-4.0 \times 10.0-12.0\mu$   
     *Hypoxylon sassafras* (Schw. ex Fr.) Curt.  
 40' Interior of stroma white or dull brown; ostioles indistinct or papillate; spores elliptic or oval . . . . . 41  
 41. Spores  $4.5 \times 9.5\mu$   
     *Hypoxylon laurus* Miller

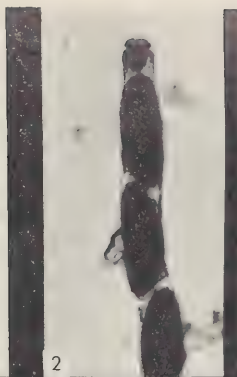
## PLATE II.

1. *Hypoxylon corticium* (*Rosellinia corticia*); ascus with apical amyloid plug. ( $\times 440$ ).
- 2, 3. Front and side views of the same, enlarged ( $\times 940$ ).
4. *Hypoxylon serpens*; developing ascus with plug. ( $\times 940$ ).
5. *Hypoxylon serpens*; ascus dehiscing, with plug displaced to one side ( $\times 940$ ).
6. *Hypoxylon mammatum*; conidiophores. ( $\times 660$ ).
7. *Hypoxylon serpens*; conidiophores ( $\times 660$ ).





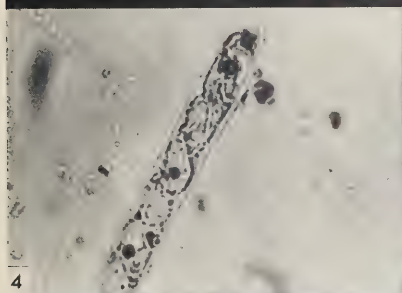
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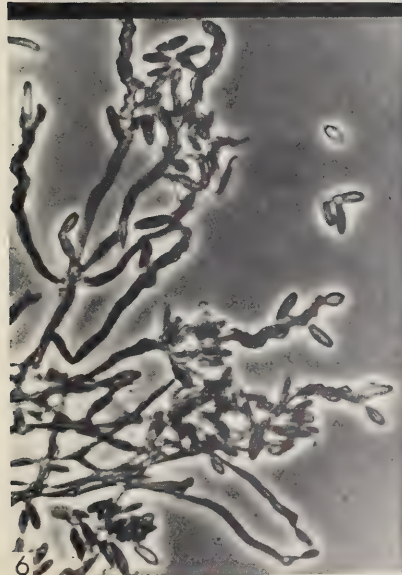
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7



- 41' Spores  $9.0 - 12.0 \times 19.0 - 23.6\mu$   
*Hypoxylon quadratum* (Schw.) E. & E.  
 syn. *Hypoxylon regale* Morgan
- 41'' Spores  $14 - 20 \times 25 - 40\mu$   
*Hypoxylon sphaerostomum* (Schw.) Sacc.
- 42 (32) Spores exceeding  $40\mu$  in length .. .. . 43  
 42' Spores not above  $30\mu$  in length .. .. . 45
43. Stroma spherical with narrow point of attachment; spores  $7.5 \times 67.5\mu$   
*Hypoxylon giganteum* (E. & E.) Martin  
 syn. *Rosellinia gigantea* E. & E.
- 43' Stroma ovoid to globular .. .. . 44  
 44. Spores  $15.0 \times 56.0\mu$   
*Hypoxylon horridum* (Rehm) Martin  
 syn. *Rosellinia horrida* Rehm
- 44' Spores  $14.0 \times 88.0\mu$   
*Hypoxylon megalospermum* (Syd.) Martin  
 syn. *Rosellinia megalosperma* Syd.
- 45 (42) Stromata uniperitheciate with globose base and conical vertex; ostiole very prominent; spores  $7.5 \times 16.5\mu$   
*Hypoxylon albolanatum* (E. & E.) Martin  
 syn. *Rosellinia albolanata* E. & E.
- 45' Stroma globose, ovoid or aplanate; one to several perithecia per stroma 46  
 46. Stroma basally immersed in the substrate; spores  $7.0 - 8.5 \times 14.5 - 16.5\mu$   
*Hypoxylon confluens* (Tode. ex Fr.) West
- 46' Stromata entirely superficial .. .. . 47  
 47. Stromata carbonaceous and black at maturity .. .. . 48  
 47' Stromata dull yellow brown, corky throughout; spores navicular to crescentic, beaked,  $14.0 \times 42.0\mu$   
*Hypoxylon morgani* E. & E.
48. Basal tissue white and clearly developed .. .. . 49  
 48' Basal tissue not clearly developed, dull white to brown .. .. . 51  
 49. Perithecia one to a few per stroma, immersed; spores inequilateral with proximal end narrower than distal,  $5.0 \times 11.5\mu$   
*Hypoxylon cuneosporum* Martin nov. sp.
- 49' Perithecia evident, spores with identical ends: stroma attached at central point .. .. . 50  
 50. Basal tissue corky and white; spores  $6.5 \times 9.0\mu$   
*Hypoxylon bermudensis* (Mill.) Martin  
 syn. *Penzigia bermudensis* Miller
- 50' Basal tissue corky, saffron; spores  $7.5 \times 10.5\mu$   
*Hypoxylon citrinum* Shear  
 syn. *Penzigia citrina* (Shear) Miller
- 51 (48) Stromata mainly uniperitheciate, or uniperitheciate stromata commonly present .. .. . 52  
 51' Stromata mainly multiperitheciate, or uniperitheciate stromata uncommon .. .. . 64  
 52. Stromata minute,  $200 - 300 \times 150\mu$ ; spores  $6.0 \times 8.5\mu$   
*Hypoxylon minutissimum* Martin nov. sp.
- 52' Stromata with relatively small perithecia not exceeding  $1,000\mu$ , and usually less than  $700\mu$  diam. .. .. . 53  
 52'' Stromata with relatively large perithecia, at least  $600\mu$  and usually exceeding  $1,000\mu$  diam. .. .. . 60  
 53. Stromata dull and minutely verrucose; spores with short linear germ slits,  $5.5 - 8.0 \times 15.0 - 19.0\mu$   
*Hypoxylon glandiformis* (E. & E.) Martin  
 syn. *Rosellinia glandiformis* E. & E.
- 53' Stromata otherwise; germ slits elongate .. .. . 54  
 54. Outer layer conspicuous, brown, granulate and contrasting with the black ostioles; spores with spiral germ slits;  $7.0 - 8.0 \times 24.5 - 27.0\mu$   
*Hypoxylon medullaris* (Wallr.) Martin

- syn. *Rosellinia medullaris* (Wallr.) C. & DN  
*R. subsimilis* Sacc.  
*R. sanguinolenta* (Wallr.) Sacc.
- 54' Outer layer not conspicuous or worn off irregularly, dark brown to black, sometimes shiny; germ slits straight .. .. . 55
55. Spores appendiculate with short hyaline appendages  $4.5 \times 9.0 \mu$  .. .. .  
*Hypoxylon apiculatum* (Sacc.) Martin  
syn. *Rosellinia apiculata* Sacc.
- 55' Spores without appendages .. .. . 56
56. Spores mucronate, oval, black,  $7.0-8.5 \times 13.5-15.0 \mu$  .. .. .  
*Hypoxylon limoniisporum* (E. & E.) Martin  
syn. *Rosellinia limoniispora* E. & E.
- 56' Spores not mucronate .. .. . 57
57. Perithecial outline hemispheric .. .. . 58
- 57' Perithecial outline globose .. .. . 59
58. Spores  $4.5 \times 8.5 \mu$   
*Hypoxylon langloisii* (E. & E.) Martin  
syn. *Rosellinia langloisii* E. & E.
- 58' Spores  $6.0 \times 9.5 \mu$   
*Hypoxylon subacutum* (Schw.) Martin  
syn. *Rosellinia subacuta* (Schw.) Sacc.
- 58'' Spores  $5.0 \times 12.5 \mu$   
*Hypoxylon ludovicianum* (Ellis) Martin  
syn. *Rosellinia ludoviciana* Ellis
- 59 (57) Stromata not aggregated, spores  $6.5 \times 10.5 \mu$   
*Hypoxylon mutans* (Cke. & Pk.) Martin  
syn. *Rosellinia mutans* (Cke. & Pk.) Sacc.
- 59' Stromata densely gregarious to aggregated or in small clusters, usually shiny; spores  $5.0 \times 9.5 \mu$   
*Hypoxylon perusensis* (Henn.) Martin  
syn. *Rosellinia perusensis* Henn.
- 60 (52) Base of stroma usually adnate to or partly enclosed by the substrate; if not adnate, then spores small in size .. .. . 61
- 60' Base of stroma narrow; not adnate to the substrate; spores large,  $7.5 \times 19.4-10.0 \times 26.5 \mu$   
*Hypoxylon corticium* (Schw.) Martin  
syn. *Rosellinia corticia* (Schw.) Sacc.
61. Spores equilateral .. .. . 62
- 61' Spores inequilateral .. .. . 63
62. Spores  $4.5 \times 8.0 \mu$   
*Hypoxylon victoriae* (Syd.) Martin  
syn. *Rosellinia victoriae* Syd.
- 62' Spores  $6.4 \times 11.5 \mu$   
*Hypoxylon protuberans* (Karst.) Martin  
syn. *Rosellinia protuberans* (Karst.)
- 62'' Spores  $7.0-8.5 \times 13.5-17.0 \mu$   
*Hypoxylon mastoideum* (Fr.) Martin  
syn. *Rosellinia mastoidea* (Fr.) Sacc.
- 62''' Spores  $12.5 \times 23.0 \mu$   
*Hypoxylon julii* (Fab.) Martin  
syn. *Rosellinia julii* Fab.
- 63 (61) Spores  $4.5 \times 9.5 \mu$   
*Hypoxylon callimorphum* (Karst.) Martin  
syn. *Rosellinia callimorpha* Karst.
- 63' Spores  $5.0-6.0 \times 11.0-17.0 \mu$   
*Hypoxylon serpens* (Pers. ex Fr.) Kickx  
syn. *Hypoxylon caries* (Schw.) Sacc.
- 63'' Spores  $6.5-9.0 \times 21.5-26.5 \mu$   
*Hypoxylon mammiformis* (Pers.) Martin  
syn. *Rosellinia mammiformis* (Pers.) C. & DN.

64 (51)	Stromata on coniferous substrate .. .. .	65
64'	Stromata on monocotyledonous substrate .. .. .	66
64''	Stromata on dicotyledonous substrate .. .. .	68
65.	Stromata on coniferous needles on the ground, aplanopulvinate; spores 6-7.5 × 12-17μ	
	<i>Hypoxylon terricola</i> Miller	
65'	Stromata on coniferous wood, pulvinate; spores 11.5 × 25.0 -12.0 × 29.0μ	
	<i>Hypoxylon diathrauston</i> Rehm	
	syn. <i>Creosphaeria pinea</i> Petrak	
66 (64)	Stromata on bamboo culms .. .. .	67
66'	Stromata on <i>Smilax</i> stems, spores 6.0-8.0 × 14.5-16.5μ	
	<i>Hypoxylon smilacicum</i> Howe	
67.	Spores 7.0 × 18.0μ	
	<i>Hypoxylon culmorum</i> Cke.	
67'	Spores 8-12 × 18-27μ	
	<i>Hypoxylon nummularioides</i> Rehm	
68 (64)	Stromata small, discrete, up to 5 mm long; spores 7.0-8.5 × 14.5- 16.5μ	
	<i>Hypoxylon confluens</i> (Tode ex Fr.) West	
68'	Stromata effuse, aplanopulvinate .. .. .	69
69.	Stroma emarginate, closely adnate to the bark, spores 6.0 × 9.0μ	
	<i>Hypoxylon grandineum</i> (Berk. & Rav.) Mill.	
69'	Stroma with definite circumscribed margin .. .. .	70
70.	Spores amber coloured to pale brown .. .. .	71
70'	Spores dark coloured .. .. .	72
71.	Ascospores oval to elliptic, 5.0-6.0 × 11.0-17.0μ	
	<i>Hypoxylon serpens</i> (Pers. ex Fr.) Kickx	
	syn. <i>Hypoxylon caries</i> (Schw.) Sacc.	
71'	Ascospores narrow elliptic, navicular to crescentic, 4.0 × 11.5μ	
	<i>Hypoxylon illitum</i> (Schw.) Curt.	
72 (70)	Stromata well developed, but with outer layer smooth, dull .. .. .	73
72'	Stromata massive with outer layer wrinkled or uneven, shiny; spores inequilateral, 5.5 × 13.0μ	
	<i>Hypoxylon adumbratio</i> Martin nov. sp.	
73.	Perithecia evident in outline, usually globose; spores inequilateral, sometimes appendiculate, 11.5 × 25.0-12.0 × 29.0μ	
	<i>Hypoxylon diathrauston</i> Rehm	
73'	Perithecia usually immersed or only vaguely evident; spores equilateral without appendages .. .. .	74
74.	Spores 4.5-6.0 × 10.0-12.5μ	
	<i>Hypoxylon albocinctum</i> E. & E.	
74'	Spores larger, 6-14 × 14-40μ	
	<i>Hypoxylon pyraerthii</i> Bres.	
75 (16)	Subiculum of matted hyphae, coarse, dark brown .. .. .	76
75'	Subiculum of closely anastomosed and crustose hyphae, fine granulate to waxy, light coloured .. .. .	86
76.	Stroma containing several loosely associated perithecia, aplanopulvin- ate; spores appendiculate at maturity, later appendages dissolve away; spores 6.5 × 14.0μ	
	<i>Hypoxylon rostrispora</i> (Ger.) Martin	
	syn. <i>Anthostomella rostrispora</i> (Ger.) Sacc.	
76'	Stroma containing one or a few perithecia .. .. .	77
77.	Spores with hyaline appendages; ends of spores usually conspicuously truncate .. .. .	78
77'	Spores without appendages, ends broad or narrow rounded .. .. .	80
78.	Appendages short, ovoid, spores 8.0 × 20.5μ	
	<i>Hypoxylon aquilum</i> (Fr.) Mart.	
	syn. <i>Rosellinia aquila</i> (Fr.) DN.	
78'	Appendages long, acuminate or acute .. .. .	79

- |         |  |    |
|---------|--|----|
| 79.     | Subiculum loosely woven, light brown, spores $6.0 \times 17.5\mu$<br><i>Hypoxylon pulcherrimum</i> (E. & E.) Martin<br>syn. <i>Rosellinia pulcherrima</i> E. & E.  |    |
| 79'     | Subiculum dense, dark brown; spores $8.0 \times 24.0\mu$<br><i>Hypoxylon thelenum</i> (Fr.) Martin<br>syn. <i>Rosellinia thelena</i> (Fr.) Rabh.   |    |
| 80 (77) | Spores produced into a fine curled tip at both ends; $11.5 \times 101.5\mu$<br><i>Hypoxylon bunodes</i> (B. & Br.) Martin<br>syn. <i>Rosellinia bunodes</i> (B. & Br.) Sacc.   |    |
| 80'     | Spores sometimes acuminate but not produced .. .. .  | 81 |
| 81.     | Perithecia not more than $1,200\mu$ diam. .. .. .  | 82 |
| 81'     | Perithecia exceeding $1,200\mu$ diam. .. .. .  | 83 |
| 82.     | Spores $7.5 \times 16.0\mu$<br><i>Hypoxylon truncatulum</i> Martin nov. comb.<br>syn. <i>Rosellinia truncata</i> Syd.  |    |
| 82'     | Spores $8 \times 30\mu$ ; species parasitic on <i>Quercus</i><br><i>Hypoxylon quercinum</i> (Hart.) Martin<br>syn. <i>Rosellinia quercina</i> Hart.  |    |
| 82''    | Spores $13.0 \times 33.0-34.5\mu$<br><i>Hypoxylon acuminosporum</i> Martin nov. comb.<br>syn. <i>Rosellinia merrillii</i> Syd.   |    |
| 82'''   | Spores $8.0 \times 50.0\mu$<br><i>Hypoxylon asperatum</i> (Masse) Martin<br>syn. <i>Rosellinia asperata</i> Masse  |    |
| 82''''  | Spores $11.5 \times 75.0\mu$<br><i>Hypoxylon gigasporum</i> (E. & E.) Martin<br>syn. <i>Rosellinia gigaspora</i> E. & E.   |    |
| 83 (81) | Spores pale brown to amber, elliptic, $7.0 \times 18.5\mu$<br><i>Hypoxylon aridicolum</i> Martin nov. sp.  |    |
| 83'     | Spores dark brown, usually opaque, variously shaped .. .. .  | 84 |
| 84.     | Conidial stage on a <i>Graphium</i> -type coremium .. .. .   | 85 |
| 84'     | Conidial stage hyphomycetous; spores oval elliptic, rather broad, inequilaterally convex, $7.5 \times 19.5-10.0 \times 26.5\mu$<br><i>Hypoxylon corticium</i> (Schw.) Martin<br>syn. <i>Rosellinia corticia</i> (Schw.) Sacc.<br><i>R. megaloeia</i> E. & E. |    |
| 85.     | Ascospores $8.0 \times 24.5\mu$<br><i>Hypoxylon buxi</i> (Fabre) Martin<br>syn. <i>Rosellinia buxi</i> Fabre   |    |
| 85'     | Ascospores $13.0 \times 34.5\mu$<br><i>Hypoxylon radiciperdatum</i> (Masse) Martin<br>syn. <i>Rosellinia radiciperda</i> Masse   |    |
| 85''    | Ascospores $7.0 \times 38.0\mu$<br><i>Hypoxylon necatrix</i> (Hart.) Martin<br>syn. <i>Rosellinia necatrix</i> (Hart.) Berl.   |    |
| 85'''   | Ascospores $5-7 \times 40-47\mu$<br><i>Hypoxylon Gothrinum</i> (B. & Br.) Martin<br>syn. <i>Rosellinia Gothrina</i> (B. & Br.) Sacc.   |    |
| 86 (75) | Subiculum pale cream to yellow .. .. .   | 87 |
| 86'     | Subiculum fawn white, stromata usually 4 15 peritheciate, spores $7.0 \times 14.5\mu$<br><i>Hypoxylon subaenum</i> (B. & C.) Martin<br>syn. <i>Rosellinia subaena</i> (B. & C.) Sacc.  |    |
| 86''    | Subiculum white, stromata uniperitheciate, on living conifer leaves, spores $9.0 \times 24.0\mu$<br><i>Hypoxylon herpotrichioides</i> (Hept. & Dav.) Mart.   |    |
| 87.     | Ectostroma brown, perithecia globose .. .. .   | 88 |

- 87' Ectostroma black, perithecia hemispheric; spores  $5.5-6.5 \times 10.0-11.5\mu$   
*Hypoxyton chrysoconium* B. & Br.  
 syn. *Rosellinia subiculata* (Schw.) Sacc.
88. Spores  $9.0 \times 24.0\mu$   
*Hypoxyton bicoloratum* Martin nov. comb.  
 syn. *Rosellinia bicolor* E. & E.
- 88' Spores  $6.3 \times 10.0\mu$   
*Hypoxyton griseocinctum* (Starb.) Mart.  
 syn. *Rosellinia griseocincta* Starb.

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